Energy Conservation Standards
Rulemaking Framework Document for
Battery Chargers and External Power Supplies

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Program

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FOREWORD

The U.S. Department of Energy (DOE) is publishing this framework document in conjunction with a draft technical report that summarizes the preliminary findings of DOE's analysis conducted in 2006 and 2007. This analysis was part of DOE's Determination Analysis for Battery Chargers and External Power Supplies (Docket No. EERE-2006-DET-0136) that the Energy Policy Act of 2005 (EPACT 2005) required DOE to perform by August 2008. The Energy Independence and Security Act of 2007 (EISA) superseded this determination analysis, redefining the scope of the analysis and extending the deadline to December 2009. Among other things, EISA also established energy conservation standards for certain types of external power supplies, directed DOE to conduct rulemakings to review and consider amending the external power supply standards, and required DOE to establish energy conservation standards for battery chargers. Given the similarities between these two products and the timing requirements imposed by Congress, DOE is bundling these two rulemakings into one proceeding, which together form the subject of this framework document.

While DOE chose in this instance to publish a draft technical report in conjunction with this framework document to provide interested parties an opportunity to review and comment on the draft analysis prepared in 2006 and 2007, interested parties should not view this action as establishing a new precedent for framework document public meetings. Because DOE was already examining these products and developing its analysis for the determination analysis when EISA altered EPCA, DOE believes that publishing this draft analysis for public review now will encourage more detailed and targeted comments from interested parties that will help DOE prepare its analysis for the next stage of this rulemaking.

Building Technologies Program
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

HOW TO SUBMIT COMMENTS

DOE seeks comments from the public on this document and any supplemental data or other information about battery chargers and external power supplies. The public may submit comments, identified by Docket Number EERE-2008-BT-STD-0005 and/or Regulation Identifier Number (RIN) 1904-AB57, by any of the following methods:

- E-mail: BC&EPS_ECS@ee.doe.gov. Include EERE-2008-BT-STD-0005 and/or RIN 1904-AB57 in the subject line of the message.
- Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.
- Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE-2J, Framework Document for Battery Chargers and External Power Supplies, EERE-2008-BT-STD-0005 and/or RIN 1904-AB57, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Please submit one signed paper original.
- Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024. Phone: 202-586-2945. Please submit one signed paper original.

For access to the docket to read background documents, a copy of the transcript of the public meeting, or comments received, go to the U.S. Department of Energy, Resource Room of the Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. For more information about visiting the Resource Room, contact Ms. Brenda Edwards, 202-586-2945.

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For information on how to submit or review public comments and on how to participate in the public meeting, contact Ms. Brenda Edwards, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE-2J, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Phone: 202-586-2945. E-mail: Brenda.Edwards@ee.doe.gov.

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LIST OF ACRONYMS AND SYMBOLS

AC	alternating current
A	ampere
Ah	ampere-hour
AEO	*Annual Energy Outlook*
AHAM	Association of Home Appliance Manufacturers
BC	battery charger
BOM	bill of materials
BT	Building Technologies Program
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CBECS	Commercial Building Energy Consumption Survey
CEA	Consumer Electronics Association
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CSL	candidate standard level
DC	direct current
DIY	do-it-yourself
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
DTR	Draft Technical Report
EERE	Office of Energy Efficiency and Renewable Energy
EIA	Energy Information Administration (DOE)
EISA	Energy Independence and Security Act of 2007
EPA	U.S. Environmental Protection Agency
EPACT 2005	Energy Policy Act of 2005
EPCA	Energy Policy and Conservation Act of 1975
EPS	external power supply
FR	*Federal Register*
GRIM	Government Regulatory Impact Model
Hg	mercury
IC	Integrated Circuit
ImSET	Impact of Sector Energy Technologies
LCC	life-cycle cost
MIA	manufacturer impact analysis
MSP	manufacturer selling price
NEMS	National Energy Modeling System
NES	national energy savings
NIA	national impact analysis
NOPR	notice of proposed rulemaking
NO_x	nitrogen oxides
NPV	net present value
OEM	original equipment manufacturer
OMB	U.S. Office of Management and Budget
PFC	Power Factor Correction

PTI	Power Tool Institute
RIA	regulatory impact analysis
SO_2	sulfur dioxide
SWEF	shipment weighted energy factor
TSD	technical support document
TSL	trial standard level
UEC	Unit Energy Consumption
U.S.C.	United States Code
V	volt
W	watt

1 INTRODUCTION

The U.S. Department of Energy (DOE) Appliance and Commercial Equipment Standards Program, within the Office of Energy Efficiency and Renewable Energy's Building Technologies Program (BT), develops and promulgates test procedures and energy conservation standards for consumer products and commercial equipment. As a general matter, the process for developing standards involves analysis, public notice, and consultation with interested parties. Such parties include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in these standards and test procedures. A DOE report to Congress[1] issued on March 4, 2009, identifies the rulemakings DOE has scheduled for completion by June 2011, including standards for, battery chargers (BCs) and external power supplies (EPSs). The report explains many of the techniques that DOE will apply during the rulemaking process to meet this schedule. In February 2008, DOE submitted a report to Congress[2] on appliance energy-efficiency rulemakings that sets forth DOE's understanding of the new requirements under the Energy Independence and Security Act of 2007 (EISA).

This Framework Document describes the procedural and analytical approaches that DOE anticipates using to evaluate energy conservation standards for BCs and EPSs. (See section 1.1 below for a discussion of the statutory authority for this rulemaking.) With this document, DOE intends to inform interested parties of the process DOE will follow for the standards rulemaking for these products, and to encourage and facilitate input from interested parties during the rulemaking. DOE views this document as a starting point for developing standards, and not as a definitive statement about any issue to be determined in the rulemaking.

Section 1 provides an overview of DOE's rulemaking process and background, and context for DOE's work on BCs and EPSs. Sections 2 through 16 discuss DOE's proposed analyses to fulfill the statutory requirements and guidance for this particular standards rulemaking. DOE will conduct separate analyses for BCs and EPSs to determine whether new or amended energy conservation standards are technologically feasible and economically justified, and would result in significant energy savings. DOE will maintain information about these rulemakings on its website, www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html.

[1] U.S. Department of Energy. *Energy Conservation Standards Activities; Submitted Pursuant to Section 141 of the Energy Policy Act of 2005 and to the Conference Report (109-275) to the FY 2006 Energy and Water Development Appropriations Act.* Jan. 31, 2006. Available at www1.eere.energy.gov/buildings/appliance_standards/pdfs/congressional_report_013106.pdf.

[2] U.S. Department of Energy. *Implementation Report: Energy Conservation Standards Activities; Submitted Pursuant to Section 141 of the Energy Policy Act of 2005 & Section 305 of the Energy Independence and Security Act of 2007*. February 2008. Available at www1.eere.energy.gov/buildings/appliance_standards/pdfs/congressional_report_0208.pdf.

Although DOE seeks comments on all aspects of the material presented in this document, specific issues are highlighted in comment boxes. DOE uses these comment boxes to ask questions about its proposed approaches for conducting the analyses required for the standards rulemaking. Requests for feedback are numbered sequentially throughout the document and are repeated in appendix E.

1.1 The Appliance and Commercial Equipment Standards Program

Title III of the Energy Policy and Conservation Act (EPCA) (42 U.S.C. 6291, *et seq*.) sets forth a variety of provisions designed to improve energy efficiency. Part A of Title III (42 U.S.C. 6291–6309) establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles." The consumer products subject to this program (referred to as "covered products") include BCs and EPSs. Section 135 of the Energy Policy Act of 2005 (EPACT 2005), Pub. L. 109-58, amended sections 321 and 325 of EPCA by inserting definitions for battery chargers and external power supplies and directing the Secretary of Energy to carry out three activities: (1) establish test procedures, (2) hold a scoping workshop to discuss plans for developing energy conservation standards, and (3) conduct a determination analysis for energy conservation standards for BCs and EPSs. (42 U.S.C. 6295(u))

DOE complied with the first of these requirements by publishing the test procedure final rule, 71 FR 71340, on December 8, 2006. This rule included definitions and test procedures for BCs and EPSs. DOE codified a test procedure for BCs in Title 10 of the Code of Federal Regulations (CFR), Part 430, Subpart B, Appendix Y ("Uniform Test Method for Measuring the Energy Consumption of Battery Chargers") and a test procedure for EPSs in 10 CFR Part 430, Subpart B, Appendix Z ("Uniform Test Method for Measuring the Energy Consumption of External Power Supplies").

Complying with the second requirement, DOE then published a notice of public meeting and availability of documentation for public review on December 29, 2006. 71 FR 78389. DOE made two documents available on its website: *Plans for Developing Energy Conservation Standards for Battery Chargers and External Power Supplies* and *The Current and Future Market for Battery Chargers and External Power Supplies*. The public meeting, called a "Scoping Workshop," was held at DOE's Forrestal Building in Washington, DC, on January 24, 2007. As EPACT 2005 required, the workshop focused on DOE's plans for developing energy conservation standards for BCs and EPSs. Information pertaining to the Scoping Workshop is available on DOE's website at
www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html.

Regarding the third requirement, on December 19, 2007, EISA, Pub. L. 110-140, was enacted, amending sections 321, 323, and 325 of EPCA. These amendments required significant changes to the determination analysis DOE had been conducting. Sections 301, 309, and 310 of EISA made several changes to EPCA related to BCs and EPSs.

First, section 301 of EISA modified some of the definitions pertaining to EPSs. EPACT 2005 defined an EPS as "an external power supply circuit that is used to convert household electric current into DC current or lower-voltage AC current to operate a consumer product." (42 U.S.C. 6291(36)(A)) Section 301 of EISA retained that definition, but created a subset of EPSs called Class A External Power Supplies. By the definition introduced by EISA, these devices are "able to convert to only 1 AC or DC output voltage at a time" and have "nameplate output power that is less than or equal to 250 watts." (42 U.S.C. 6291(36)(C)(i)) Section 301 of EISA further amended EPCA by establishing standards for Class A EPSs, effective July 1, 2008, and directing DOE to conduct two successive rulemakings to review, and consider amending, the energy conservation standards for EPSs, the first of which is required to be completed by July 1, 2011.

Second, section 309 of EISA amended section 325(u)(1)(E) of EPCA, instructing DOE to issue no later than two years after EISA's enactment a final rule determining whether to issue energy conservation standards for external power supplies or classes of external power supplies. (42 U.S.C. 6295(u)(1)(E)(i)(I)) However, DOE cannot conduct a determination analysis on whether it should issue conservation standards for a product for which standards have already been set by Congress in section 301(c) of EISA (*i.e.*, Class A external power supplies). Furthermore, section 325(u)(1)(E) of EPCA, as amended by EISA, directs DOE to complete this determination analysis ''No later than 2 years after the date of enactment of this subsection.'' (42 U.S.C. 6295(u)(1)(E)(I)) This subsection, however, is a result of EPACT, which was signed into law on August 8, 2005. Interpreting this subsection strictly as amended by EISA would place the determination analysis final rule issue date on August 8, 2007, more than four months prior to the passage of EISA.

To resolve these inconsistencies, DOE interprets the ''date of enactment of this subsection'' (42 U.S.C. 295(u)(1)(E)(I)) as the date of passage of EISA, namely December 19, 2007. In this context, DOE interprets sections 301 and 309 of EISA jointly as a requirement to determine, by December 19, 2009, whether energy conservation standards shall be issued for EPSs that are covered, but are not classified as Class A external power supplies. Examples of these EPSs include those with nameplate output power greater than 250 watts, those that are able to convert to more than one AC or DC output voltage at the same time, and those excluded from coverage under Class A External Power Supplies (*e.g.*, medical devices). Section 309 also required DOE to issue a final rule prescribing energy conservation standards for BCs, if technologically feasible and economically justified, by July 1, 2011. (42 U.S.C. 6295(u)(1)(E)(i)(II))

Finally, section 310 of EISA established definitions for active mode, standby mode, and off mode, and directs DOE to amend its existing test procedures for both BCs and EPSs to measure the energy consumed in standby mode and off mode. (42 U.S.C. 6295(gg)(2)(B)(i)) DOE satisfied this requirement by publishing a final rule that incorporated standby and off mode measurement into the DOE test procedure. 74 FR 13318 (March 27, 2009). It also amended the definitions of standby mode and off mode to better adapt them to how consumers use battery chargers and external power supplies.

The above discussion summarizes the pertinent legislative and regulatory history for BCs and EPSs. It sets the stage for the issues raised in the balance of this framework document, which initiates an energy conservation standards rulemaking for BCs and EPSs, to be completed by July 1, 2011, as required by EISA. (42 U.S.C. 6295(u)(1)(E)(i)(II) and 42 U.S.C.

6295(u)(3)(D)(i)) In this rulemaking, DOE will consider setting new standards for BCs and will consider amending existing standards for Class A EPSs, consistent with sections 309 and 301, respectively, of EISA. When setting any new standard, DOE will also consider the energy consumed in standby mode and off mode for these products consistent with EPCA, as amended by section 310 of EISA. See appendix B for the statutory definitions of BCs, EPSs, and Class A EPSs.

1.2 Overview of the Rulemaking Process

1.2.1 Test Procedures

EPACT 2005 directed DOE to establish test procedures for BCs and EPSs. DOE complied with this requirement by publishing the test procedure final rule, 71 FR 71340, on December 8, 2006, which included definitions and test procedures for BCs and EPSs.

As noted above, EISA further amended EPCA by defining active mode, standby mode, and off mode. EISA also directed DOE to amend its existing test procedures for both BCs and EPSs to measure the energy consumed in standby and off modes. To comply with this requirement, DOE published a notice of proposed rulemaking (NOPR) on August 15, 2008, 73 FR 48054. In that NOPR, DOE also proposed a new test procedure to help with the determination analysis required under section 325(u)(1)(E)(i)(I) of EPCA, as amended by EISA. (42 U.S.C. 6295(u)(1)(E)(i)(I)) This test procedure would provide a method for measuring the standby mode, off mode, and average efficiency of multiple-voltage EPSs.

Following a public meeting held on September 12, 2008, and after receiving comments from interested parties, DOE published a final rule on March 27, 2009. 74 FR 13318. In the final rule, DOE amended its test procedures for BCs and EPSs to include provisions for measuring standby-mode and off-mode energy consumption. However, due to the limited time provided by EISA and limited resources available prior to the publication of this final rule, DOE was unable to address the large number of stakeholder comments received on some of the other aspects of the NOPR and decided to defer action on these issues and the incorporation of multiple-voltage EPSs to a later rulemaking that will address changes to both the BC and EPS test procedures.

1.2.2 Rulemaking Process and Interested Party Participation

When DOE evaluates any new or amended energy conservation standard for "covered products," EPCA, as amended, specifies that any standard DOE prescribes for consumer products shall be designed to "achieve the maximum improvement in energy efficiency . . . which the Secretary [of Energy] determines is technologically feasible and economically justified." (42 U.S.C. 6295(o)(2)(A)) Moreover, EPCA states that the Secretary may not establish an amended standard if such standard will not result in a "significant conservation of energy," or "is not technologically feasible or economically justified." (42 U.S.C. 6295(o)(3)(B)) In determining whether a standard is economically justified, DOE considers, to the greatest extent practicable, the following seven factors (42 U.S.C. 6295(o)(2)(B)(i)):

(1) the economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard;
(2) the savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;
(3) the total projected amount of energy (or, as applicable, water) savings likely to result directly from the imposition of the standard;
(4) any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;
(5) the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;
(6) the need for national energy and water conservation; and
(7) other factors the Secretary considers relevant.

Additional statutory requirements for prescribing new or amended standards are set forth in 42 U.S.C. 6295(o)(1)–(2)(A), (2)(B)(ii)-(iii), and (3)–(5).

The process for developing new or amended energy conservation standards involves analysis, public notice, and consultation with interested parties. Such parties generally include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in energy conservation standards and test procedures. DOE considers the participation of interested parties a very important part of the rulemaking process. The broad array of interested parties who routinely provide comments during this process promotes a balanced discussion of critical information required to conduct the standards rulemaking. Accordingly, DOE encourages the participation and interaction of all interested parties during the comment period provided at each stage of the rulemaking.

In conducting the test procedure rulemakings and the energy (and water) conservation standards rulemakings, DOE involves interested parties through a variety of means, including formal public notifications (*i.e.*, *Federal Register* notices) and public meetings. As discussed in further detail below, the standards rulemaking process involves a preliminary publication of analyses on the Department's website, and two major public notices, which are published in the *Federal Register*. The publication of the preliminary analyses as well as the NOPR will be accompanied by public meetings to solicit comment from interested parties to guide the rulemaking process.

- *Preliminary publication of analyses and public meeting* (section 1.3): The preliminary publication of analyses and public meeting is designed to obtain public review of the models and tools that DOE will use in the rulemaking and to facilitate public participation before the proposed rule stage. Candidate standard levels (CSLs), which span the range of efficiencies from baseline products to the most efficient technology, are the basis for demonstrating the functionality of the models and tools.[3]

[3] In the past DOE issued an Advance Notice of Proposed Rulemaking (ANOPR) following publication of the framework document. The Energy Independence and Security Act of 2007 eliminated the requirement that DOE issue ANOPRs as part of the standards rulemaking process, see EISA, at sec. 307. DOE is now using an alternate

- *NOPR* (section 1.4): The NOPR presents a discussion of comments received in response to the preliminary analyses; DOE's analysis of the impacts of standards on consumers, manufacturers, and the nation; DOE's weighing of those impacts; and the proposed standard levels for public comment.

- *Final rule* (section 1.5): The final rule presents a discussion of comments received in response to the NOPR, the revised analysis of the impacts of standards, DOE's weighting of the impacts, and the standard levels DOE is adopting. The final rule also establishes the effective date of the standards.

DOE has prepared and intends to follow the schedule below for the BC and EPS energy conservation standards rulemaking.

Table 1.1. Rulemaking Schedule for BC and EPS Energy Conservation Standards

Rulemaking Notice	Publication Date
Framework Document	May 2009
Preliminary Analyses Public Meeting Notice	March 2010
NOPR	December 2010
Final Rule	July 1, 2011 (EISA Deadline)

Any amended standards for Class A EPSs promulgated by the Final Rule would apply to products manufactured on or after July 1, 2013. (42 U.S.C. 6295(u)(3)(D)(i)) A compliance date for new BC standards has not yet been established since EISA did not set one.

1.3 Pre-Rulemaking Analyses and Other Activities

DOE's initial pre-rulemaking activity typically includes identifying product technology options and determining whether they warrant detailed analysis or can be eliminated from further consideration. This process includes a market and technology assessment (section 3) and a screening analysis (section 4). DOE applies four criteria in the screening analysis to determine which technology options to eliminate from further consideration: technological feasibility; practicability to manufacture, install, and service; adverse impacts on product utility or availability; and adverse impacts on health or safety. DOE calls technologies that pass the screening analysis "design options," and considers them in the engineering analysis as methods of improving the efficiency of the covered products.

Also in the pre-rulemaking stage of the analysis, DOE collects manufacturer cost data, historical shipment data, shipment-weighted average efficiency data, and preliminary manufacturer impact data (*e.g.*, capital conversion expenditures, marketing costs, and research and development costs). Given these data, and the efficiency levels achievable by the design options developed earlier, DOE estimates the impact of potential standards on individual

process to provide the same information and opportunity for public comment as the ANOPR, but without publication of analyses in the *Federal Register*.

consumers and the Nation as a whole. These calculations are contained within the following analyses, explained in subsequent sections of this framework document:

- the engineering analysis (section 5);
- the consumer life-cycle cost (LCC) and payback period (PBP) analyses (section 8);
- the national impact analysis, which considers national energy savings (NES) and national consumer net present value (NPV) (section 10); and
- a preliminary manufacturer impact analysis (section 12).

DOE will present the results of these analyses in a technical support document (TSD) to be published prior to the NOPR stage of the rulemaking. The preliminary TSD, which will be made available on the Department's website, will be followed by a preliminary analyses public meeting. A meeting agenda, presentation slides, and an executive summary highlighting the issues on which DOE seeks comment will accompany the TSD on the website. DOE will publish a notice announcing the availability of the materials and the meeting in the *Federal Register*.

Discussion of various CSLs in the preliminary TSD will facilitate review by interested parties of the spreadsheet models that underpin the analyses. DOE will use these comments to refine the models for the NOPR stage of the rulemaking analyses, where DOE will propose specific efficiency levels for adoption. Based on the results, DOE selects CSLs from the energy-efficiency or energy-use levels considered in the preliminary analyses. In addition to the efficiency levels corresponding to the maximum technologically feasible ("max-tech")[4] design and the minimum LCC point, DOE generally selects for consideration levels or design options that span the full range of technologically achievable efficiencies. DOE typically analyzes the following CSLs:

- the baseline CSL (*i.e.*, the minimum level) is represented by the product with the lowest energy-efficiency level currently sold on the market for a given product class; for classes where energy-efficiency standards already exist, the baseline efficiency level is typically defined by the existing energy conservation standard;

- the highest CSL or lowest energy consumption level that is technologically feasible (*i.e.*, the "max-tech" level);

- the level with the minimum LCC or greatest LCC savings; and

- levels that incorporate noteworthy technologies or fill in large gaps between other CSLs considered.

In the preliminary analyses DOE uses analytical models and tools to assess the different product classes at each efficiency or energy use level analyzed. Many of these analytical models and tools are in the form of spreadsheets, some of which DOE uses to conduct the LCC and PBP analyses and to determine the NES and NPV of prospective standards. Preliminary results may

[4] The "max tech" represents the most efficient design that is commercialized or has been demonstrated in a prototype with materials or technologies available today. "Max tech" is not constrained by economic justification, and typically is the most expensive design option considered in the engineering analysis.

facilitate discussions among interested parties on potential joint recommendations for standard levels.

In addition to the other materials mentioned above, DOE will make the spreadsheet tools used for the preliminary analyses available on its website for review and will consider comments after the public meeting.[5] DOE will provide a 60-day public comment period following the publication of the preliminary analyses notice. At that point, DOE encourages interested parties to develop joint recommendations for standard levels to the extent possible.

1.4 Notice of Proposed Rulemaking

In developing the NOPR, DOE will first review and consider all the comments it receives after the public meeting. This process may result in revisions or refinements to the preliminary analyses, including the engineering and LCC analyses. DOE will also conduct additional economic and environmental impact analyses at this stage of the rulemaking. These analyses generally include a consumer LCC subgroup analysis (section 11), a complete manufacturer impact analysis (section 12), a utility impact analysis (section 13), an employment impact analysis (section 14), an environmental assessment (section 15), and a regulatory impact analysis (section 16).

DOE will describe the methodology used and make the results of all the analyses available on its website for review and comments. Based on comments from interested parties, DOE may further revise the analyses. This analytical process ends with the selection of a proposed standard level (if any) for each product class that DOE will present in the NOPR. DOE selects the proposed standard levels from the trial standard levels (TSLs) analyzed during the NOPR phase of the rulemaking, equivalent to the CSLs analyzed during the preliminary analyses. The NOPR, published in the *Federal Register*, will document the evaluation and selection of any proposed standards levels, along with a discussion of other TSLs considered but not selected, including the reasons for not selecting them.

In selecting proposed efficiency standards, DOE generally first identifies the max-tech efficiency level. If DOE proposes a level lower than that, it will explain sequentially the reasons for eliminating each higher level, beginning with the highest level considered. DOE will present the analytical results in the NOPR, with the details of the analysis provided in an accompanying TSD.

DOE considers many factors in selecting proposed standards, as described above in section 1.3. These factors and the associated criteria are specified in EPCA and consider the benefits, costs, and impacts of energy conservation standards. Additionally, DOE encourages interested parties to develop joint recommendations for standard levels. DOE will carefully consider such recommendations in its decision process.

When DOE publishes the NOPR, it will provide the Department of Justice (DOJ) with copies of the NOPR and TSD to solicit feedback on the impact on competition that the proposed

[5] All materials associated with the battery chargers and external power supplies rulemakings are available on DOE's website at *www1.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html*.

standard levels would have. DOJ will review these standard levels in light of any lessening of competition that is likely to result from the imposition of standards. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) Publication of the NOPR will be followed by a public meeting and a 60-day public comment period.

1.5 Final Rule

After the publication of the NOPR, DOE will consider public comments that it receives on the proposal (including TSLs) and accompanying analyses. On the basis of the public comments, DOE will review the engineering and economic impact analyses and proposed standards and consider modifications where necessary. Before issuing the final rule, DOE will also consider DOJ comments on the impacts of the proposed standard levels on competition to determine whether changes to these standard levels are needed.

The standards rulemaking will conclude with the publication of the final rule. DOE will select the final standard level based on the complete record of the standards rulemaking. The final rule will specify the final standard level and its effective date and explain the basis for the selection. The final rule will be accompanied by a final TSD.

2 OVERVIEW OF ANALYSES FOR RULEMAKING

Analyses are conducted in support of the standards rulemaking to ensure that DOE selects energy conservation standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in significant energy savings. Economic justification includes the consideration of economic impacts on domestic manufacturers and consumers, national benefits including environmental impacts, issues of consumer utility, and impacts from any lessening of competition. DOE expects the selection of such standards to achieve the maximum energy savings that are economically justified without imposing an undue financial burden on any particular party.

Figure 2.1 summarizes the analytical components of the standards-setting process. The analyses are presented in the center column. Each analysis has a set of key inputs, which are data and information required for the analysis. The identified approaches are the methods that DOE will use to obtain key inputs, which may vary depending on the information in question. DOE will collect other information from interested parties or experts with special knowledge and develop analyses and other information in support of this rulemaking. The results of each analysis are key outputs, which feed directly into the rulemaking. Arrows indicate the flow of information among the various analyses. DOE ensures a consistent approach to its analyses throughout the rulemaking by considering each analysis as a part of the overall standards-setting framework. DOE intends to conduct each of these analyses separately for BCs and EPSs.

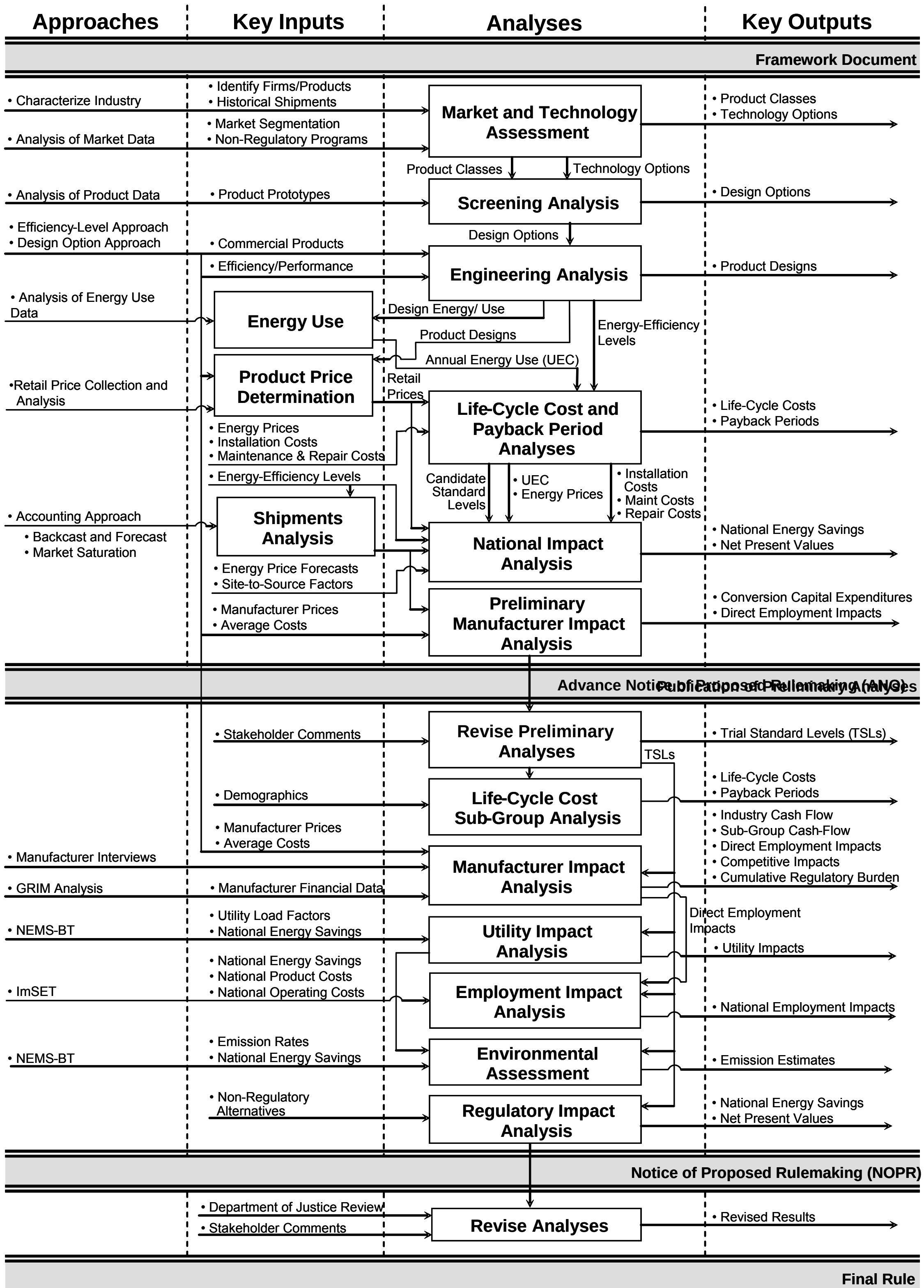


Figure 2.1. Analyses Conducted for an Energy Conservation Standard Rulemaking

Before the enactment of EISA, DOE was working to determine whether it should set standards for BCs and EPSs, as required by EPACT 2005. In a separate draft technical report published in conjunction with this framework document, DOE presents the determination analysis that it had been developing for BCs and EPSs. DOE invites interested parties to review the draft technical report and provide comments to DOE on all aspects of the draft analysis pertaining to the energy conservation standards rulemaking initiated by this framework document. All the major issues associated with the analysis presented in the draft technical report are identified for comment by "Item" boxes throughout this framework document. The draft technical report provides more detail on these issues by characterizing DOE's current understanding of the technology and market for BCs and EPSs, as well as the inputs and methods DOE proposes to use in its future analyses.

DOE developed the draft technical report, which is being made available in conjunction with this framework document, as part of the determination analysis on BCs and EPSs DOE is conducting under EPACT 2005. That determination analysis, however, was superseded by EISA, which modified its scope and schedule and initiated rulemakings to consider new and amended standards for BCs and EPSs, respectively. The publication of the draft technical report, therefore, represents a special case, and should not be construed as setting a precedent for future DOE action in conjunction with the publication of a framework document.

Item 1 *DOE invites interested parties to review the draft technical report published in conjunction with this framework document and to provide comments on the analytical structure, inputs, and method DOE followed.*

3 MARKET AND TECHNOLOGY ASSESSMENT

The market and technology assessment will provide information about BC and EPS manufacturers and specifics about the performance attributes of BCs and EPSs. This assessment is particularly important at the outset of the rulemaking for developing product classes and identifying technology options that improve the efficiency of BCs and EPSs.

3.1 Definitions

A key issue in DOE's BC and EPS rulemakings is the necessity for clear and distinct product definitions. DOE has taken several approaches in the past, but with the current rulemakings, the need for regulatory definitions based on an interpretation of the EPCA statutory language is becoming more pressing. Therefore, before discussing any analysis, DOE will review the current statutory definitions and discuss the possible interpretation of these definitions, with the goal of establishing regulatory definitions that provide greater clarity for interested parties.

3.1.1 Current Statutory Definitions

Title III of EPCA (42 U.S.C. 6291, *et seq.*) sets forth a variety of provisions designed to improve energy efficiency. Part A of Title III (42 U.S.C. 6291–6309) establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles."[6] Section 135 of EPACT 2005, Pub. L. 109-58, amended sections 321 and 325 of EPCA, inserting definitions for BCs and EPSs into the list of covered products. Subsequently, Section 301 of EISA created a subset of EPSs designated as Class A. The relevant portions of these acts follow:

Battery Charger

The term battery charger means a device that charges batteries for consumer products, including battery chargers embedded in other consumer products. (42 U.S.C. 6291(32))

External Power Supply

The term external power supply means an external power supply circuit that is used to convert household electric current into DC current or lower-voltage AC current to operate a consumer product. (42 U.S.C. 6291(36)(A))

Class A External Power Supply

i. IN GENERAL- The term class A external power supply means a device that—
   I. is designed to convert line voltage AC input into lower voltage AC or DC output;
   II. is able to convert to only 1 AC or DC output voltage at a time;
   III. is sold with, or intended to be used with, a separate end-use product that constitutes the primary load;
   IV. is contained in a separate physical enclosure from the end-use product;
   V. is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord, or other wiring; and
   VI. has nameplate output power that is less than or equal to 250 watts.

ii. EXCLUSIONS- The term class A external power supply does not include any device that—
   I. requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c); or
   II. powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated. (42 U.S.C. 6291(36)(C))

Consumer Product

The term consumer product means any article (other than an automobile, as defined in section 32901 (a)(3) of title 49) of a type—

A. which in operation consumes, or is designed to consume, energy or water with respect to showerheads, faucets, water closets, and urinals; and
B. which, to any significant extent, is distributed in commerce for personal use or consumption by individuals without regard to whether such article of such type is in fact distributed in commerce for personal use or consumption by an individual, except

[6] This part was originally titled Part B but it was redesignated Part A in the United States Code for editorial reasons.

that such term includes fluorescent lamp ballasts, general service fluorescent lamps, incandescent reflector lamps, showerheads, faucets, water closets, and urinals distributed in commerce for personal or commercial use or consumption. (42 U.S.C. 6291(1))

Detachable Battery

The term detachable battery means a battery that is—

A. contained in a separate enclosure from the product; and
B. intended to be removed or disconnected from the product for recharging. (42 U.S.C. 6291(52))

3.1.2 Additional Definitions

The following additional terms are used by DOE throughout this framework document to provide clarification and further describe components of BCs and EPSs:

Wall Adapter. DOE uses the term "wall adapter" to refer to any external power adapter (Figure 3.1) that connects a consumer product to the household electric supply (AC mains). Wall adapters, which consist of a power conversion circuit housed in a plastic enclosure and typically connected to a product through an output cord, provide many functions, the most important of which is safety. All wall adapters isolate the consumer product from mains and reduce the voltage, thereby reducing the risk of shock.[7]

In addition to performing isolation and conversion functions, wall adapters may also provide functions such as rectification (AC/DC conversion), voltage regulation, and/or control of the charge current from AC mains to the battery for safe charging. There are no distinguishing physical features (*e.g.*, size, shape, etc.) that would allow an observer to determine the internal circuitry (and the corresponding functions) of a wall adapter. Furthermore, some adapters can provide different functions depending on their region of operation—*i.e.*, the output current and voltage at a particular time.

Wall Adapter

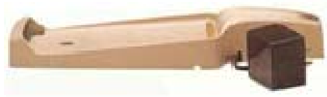
Desktop Adapter

Figure 3.1 Example of a Wall Adapter and a Desktop Adapter, Treated Together as "Wall Adapters"

Cradle or Charging Base. For many rechargeable consumer products, the battery may be charged using a "cradle" or "charging base" (Figure 3.2). Some cradles and charging bases use a wall adapter in tandem, while others perform the same power conversion and isolation functions, rendering wall adapters unnecessary. Similar to wall adapters, cradles and charging bases have

[7] A transformer within the adapter—which also serves to reduce the voltage level from the mains voltage of 120 V AC—passes power while blocking the direct electrical path between input and output.

no distinguishing physical features that would allow an observer to conclusively determine their internal circuitry and function.



Handheld vacuum cleaner cradle
(shown with wall adapter)

Power tool battery charging base
(no wall adapter)

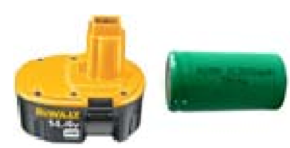
Figure 3.2 Example of a Cradle and a Charging Base

> ***Item 2*** *DOE welcomes comment from interested parties on differentiating between wall adapters and cradles. DOE also seeks comment on the type of circuitry (or lack thereof) typically contained in cradles.*

Battery. For this rulemaking, DOE considers "batteries" to be one or more sealed electrochemical cells that provide power to a consumer product, allowing it to operate while disconnected from AC mains. Products may use batteries in standard-size (*e.g.*, AA, AAA, etc.) packages or non-standard, product-specific packages. Batteries may also be packaged with additional circuitry to prevent overcharging, or to detect faults or charge status. Examples of batteries are illustrated in Figure 3.3.

Standard-size batteries

Laptop battery
pack



Power tool battery pack
shown with sub-C cell (not to scale)

Figure 3.3 Examples of Batteries

Battery charging system. The term "battery charging system" refers to all the components necessary to charge and maintain a battery, from the AC wall plug to the battery itself, and includes the wall adapter, cradle, and—if the battery is integral to the consumer product—the product itself. Which parts of a battery charging system are considered the battery charger (BC), and therefore subject to this standards rulemaking, depends on the interpretation of the BC definition, just as which wall adapters are considered EPSs depends on the interpretation of the EPS definition. In other words, "BC" and "EPS" are regulatory terms subject to interpretation, while "battery charging system" and "wall adapter" are terms that describe physical objects. In the following discussion, care has been taken to distinguish between these regulatory and physical terms.

3.2 Scope of this Rulemaking

EPCA, as amended by EISA, requires DOE to conduct this standards rulemaking on BCs and Class A EPSs. However, the statutory definitions of these two terms leave substantial room for interpretation. Comments received from interested parties during the public meeting on the standby and off mode test procedure NOPR on September 12, 2008, emphasized that many interested parties were unsure how to classify their products. Specifically, because wall adapters are sometimes used with battery charging systems and because the definitions of BCs and EPSs are not mutually exclusive, it is unclear which portions of the system fall under the EPS and BC definitions, respectively.

To be clear, when a wall adapter meeting the EPS definition powers any application other than a battery charging system, DOE considers that device to be an EPS. Similarly, in cases where a battery charging system meets the BC definition, and does not use a wall adapter, DOE considers the entirety of the system to be a BC. Only in cases when a wall adapter powers a battery charging system is the situation ambiguous. These three cases are illustrated in Figure 3.4.

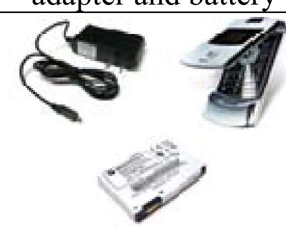
Category	**Wall adapter not powering a battery charging system (considered an EPS)**	**Battery charging not powered by a wall adapter (considered a BC)**	**Unclear how DOE should consider the wall adapter and battery charging system components**
Example	(a) Computer monitor with wall adapter	(b) Universal charger for AA batteries	(c) Cell phone with wall adapter and battery
Illustration			

Figure 3.4. Examples of the Three Categories of Products DOE is Considering for Inclusion in This Rulemaking

How DOE interprets this term will affect both this rulemaking and the scope of other rulemakings underway for BCs and EPSs described earlier in section 1. More immediately, DOE's interpretation of Class A EPS will also affect which wall adapters are subject to the EISA Class A EPS standards that became effective on July 1, 2008. The following subsections will discuss possible interpretations of the BC and EPS definitions and the impact of these interpretations on energy conservation standards.[8]

[8] DOE outlined an interim approach to differentiating BCs and EPSs at the Scoping Workshop Public Meeting on Developing Energy Conservation Standards for BCEPS, on January 24, 2007. At that time, DOE indicated that it might review and revise this approach as well as consider whether devices serving both BC and EPS functions should be subject to both standards. The following subsections are intended to present this revision.

3.2.1 Wall Adapters That Do Not Power Battery Charging Systems

As mentioned above, DOE considers wall adapters that meet the EPS definition and that do not power a battery charging system to be EPSs. Furthermore, based on the EISA definition for Class A EPS (42 U.S.C. 6291(36)(C)), DOE considers a wall adapter that meets the following conditions to fall within the scope of this rulemaking:

(1) Able to convert to only one AC or DC output voltage at a time;
(2) Has nameplate output power that is less than or equal to 250 watts; and
(3) Does not power:
    i. any device that requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act; or
    ii. the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated.

EPSs excluded from the Class-A EPS definition (42 U.S.C. 6291(36)(C)) are not within the scope of this rulemaking, and will be covered in a separate rulemaking on non-Class A EPSs, as required by EISA. (42 U.S.C. 6295(u)(1)(E)(i)(I)) That separate rulemaking will determine whether energy conservation standards shall be issued for four types of EPSs:

(1) *Multiple-Voltage EPSs*: These devices are able to convert to more than one AC or DC output voltage at a time.
(2) *High-Power EPSs*: These devices have a nameplate output power greater than 250 watts.
(3) *Medical EPSs*: These devices are used to power medical devices regulated by the Food and Drug Administration.
(4) *EPSs for Particular Battery Charging Applications*: These devices provide power to battery chargers of detachable batteries or batteries of products that are motor operated. The devices included in this type are heavily dependent on the interpretation of the BC and EPS definitions chosen by DOE, as discussed in section 3.2.3.1.

While the first two types of non-Class A EPSs are easily understood, the exclusions for EPSs that power medical devices and particular battery charging applications are more nuanced. The former is explained in section 3.2.1.1, the latter, in section 3.2.3.1.

3.2.1.1 Medical EPSs

The definition of Class A EPS excludes, in relevant part, "any device that (I) requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c)." (42 U.S.C. 6291(36)(C)(ii)(I)) While this language may appear clear on its face, it raises a number of interpretive issues.

First, it is unclear whether the exclusion should apply only to EPSs that are themselves listed as medical devices or also to EPSs that are components of listed medical devices. A literal reading of EPCA would exclude from Class A only those EPSs that are themselves medical devices. A search of the Food and Drug Administration's (FDA) product classification database for "power supply," however, shows that of the approximately 1,700 types of medical devices, only one device might be an EPS—an auxiliary power supply (ac or dc) for an external transcutaneous cardiac pacemaker.

However, there are several other types of medical devices that may have EPSs as components, for example, nebulizers and sleep therapy devices. These medical devices are tested, listed, and approved for use with specific EPSs, which must meet the safety standards codified in International Electrotechnical Commission (IEC) Standard 60601-1. Furthermore, once the medical device has been approved for use with the EPS, the EPS is not interchangeable and can be considered an integral part of the medical device. Thus, DOE interprets EPCA to also exclude from Class A those EPSs that power medical devices.

Second, the exclusion applies to devices that are required to be listed and approved under 21 U.S.C. 360c. Section 360c creates three classes of medical devices (Classes I through III), all of which are subject to the listing requirements of FDA regulations. Similarly, each class requires some level of approval by FDA, ranging from the filing of forms with the agency (such as 510(k) approval filings) to premarket approvals for devices intended for human use (as occurs with Class III medical devices, which pose a higher degree of risk to users). [9]

Each device covered under Section 513 requires regulatory oversight by the FDA because of its impact on the public health. Since these devices play a vital role in helping to ensure public health, DOE believes that the exclusion created by Congress was designed to prevent any adverse impact on the public with respect to the safety of these regulated devices. This concern is highlighted by DOE's obligation under EPCA to consider the performance of a regulated product when subjected to a new standard, as well as other factors that the agency considers relevant—such as the health and safety of the public, which could be put at risk by imposing limits on energy usage. (42 U.S.C. 6295(o)(IV) and (VII))

Accordingly, given the language provided by Congress with respect to this exclusion and the criteria set out under EPCA, DOE believes that under the most reasonable interpretation, this exclusion applies to all EPSs that are Class I, II, and III medical devices or that are components of such devices.

Item 3 *DOE requests comment from interested parties on its interpretation of the Class A EPS exclusion of medical EPSs.*

3.2.2 Battery Charging Systems Not Powered by Wall Adapters

According to its statutory definition, a BC is "a device that charges batteries for consumer products, including battery chargers embedded in other consumer products." (42 U.S.C. 6291(32)) DOE considers all components of a system that meet this definition—but not

[9] "Classify Your Medical Device," Center for Devices and Radiological Health, U.S. Food and Drug Administration. www.fda.gov/cdrh/devadvice/313.html.

necessarily the wall adapter, discussed further in section 3.2.3—to be within the scope of this rulemaking on BCs and Class A EPSs.

3.2.2.1 DC-Powered Battery Charging Systems

DOE also intends to include within this rulemaking battery charging systems that draw power from DC sources other than wall adapters. These DC sources include, for example, computer universal serial bus (USB) ports and automobile cigarette lighter receptacles. DOE believes these BCs are within the scope of the rulemaking because the BC definition—unlike the EPS definition—does not specify that the device input power must be AC. Furthermore, these BCs are a type of product "other than an automobile . . . which in operation consumes, or is designed to consume, energy"—*i.e.*, "electricity, or fossil fuels." (42 U.S.C. 6291(1) and (3))

A potential complication with including DC-powered chargers arises in the case of wall adapters with a USB output, as shown in Figure 3.5(b). A USB-powered charger embedded in a portable device can draw power from either a computer (Figure 3.5(a)) or one of these wall adapters. However, the USB output of this adapter could not only power a battery charger embedded in, for example, a portable music player, but also a consumer product without a battery. If the USB wall adapter is not designed for a specific battery charging system, but is sold as an after-market accessory, DOE proposes to treat it as a wall adapter that does not power a battery charging system (*i.e.*, an EPS). If, however, it is packaged and sold together with a battery charging system, DOE proposes to treat it as a wall adapter for that system, according to one of the approaches presented in section 3.2.3.

(a) USB port on a laptop computer

(b) USB port on a wall adapter

Figure 3.5 Examples of USB ports.

Item 4 *DOE seeks comments on including DC-powered battery chargers within the scope of the BC standards analysis.*

3.2.3 Battery Charging Systems Powered by Wall Adapters

The current definitions for BCs and EPSs are not mutually exclusive. This fact becomes problematic when wall adapters (which can be considered EPSs) are a part of battery charging systems. While some of these wall adapters are electrically equivalent to wall adapters that power non-battery charging applications, others operate differently by providing additional functions necessary for battery charging.

These additional functions include current and temperature sensing, timing, and current limiting, all of which are included in battery charging systems for safety reasons. When manufacturers decide to use a wall adapter to perform the power conversion for a battery charging system, they may also shift some of these charge control functions to the wall adapter, as illustrated in Figure 3.6.

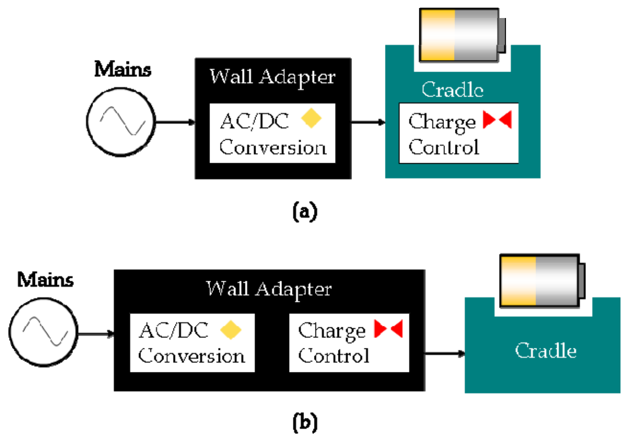


Figure 3.6. Charge Control Circuitry Required for Battery Charging Can Be Contained in (a) the Cradle or Charging Base, or (b) the Wall Adapter

Wall adapter constant-voltage (CV) sources perform only AC/DC conversion functions, converting mains power at 120 volts AC to low-voltage DC power suitable for the safe operation of electronic products. Constant-voltage sources provide a fixed voltage regardless of the current drawn by the end-use product load (as long as the current remains within the specified region of operation and given some imperfections due to regulation—*i.e.*, the dependence of output voltage on load current).

Wall adapter constant-current (CC) sources also operate at low DC voltages; however, their output characteristics are opposite those of constant-voltage sources. Rather than provide a fixed voltage regardless of the current, they provide a fixed current, regardless of the load voltage. The latter characteristic is necessary in battery charging applications to limit charging current into the battery—as the battery voltage varies from fully discharged to fully charged, the constant-current source will maintain the charge current at a safe level and prevent overheating of the battery.

Referring again to Figure 3.7, it is possible to see how the constant-current and constant-voltage sources are combined in a typical charger design for lithium-ion or lead-acid batteries. The wall adapter will act as a constant-current or constant-voltage source depending on its region of operation. When the battery is discharged and its voltage is low (see the bottom portion of Figure 3.7), the charger operates as a constant-current source, limiting the charge current flowing into the battery. However, when the battery is charged and its voltage is high (see the top portion of Figure 3.7), the charger operates as a constant-voltage source, outputting a fixed voltage and maintaining full charge.

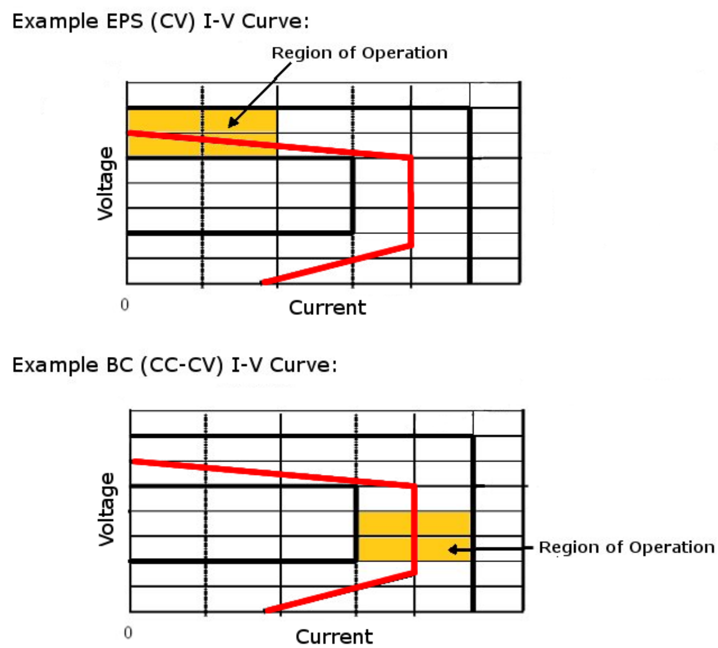


Figure 3.7. The Same Wall Adapter Can Be Used for Both BC and EPS Functions, Depending on Which Portion of Its Current-Voltage (I–V) Curve It Is Operating

In other words, some wall adapters used in a battery charging system may do more than "convert household electric current into DC current or lower-voltage AC current"—the role of an EPS, according to the EPACT 2005 definition. (42 U.S.C. 6291(36)(A)) These additional charge control functions may add to the cost and power consumption of the wall adapter, and may even make it functionally unsuitable for use with other, non-battery charging applications.

Once the EPS definition has been interpreted to either include or exclude wall adapters, DOE must then interpret the BC definition, which is also ambiguous. Specifically, the BC definition does not specify the input power source for the battery charger. As a result, in cases such as the one illustrated in Figure 3.6(a), where the wall adapter only performs power conversion and no battery charging functions, it is unclear whether to consider the entire battery charging system (*i.e.*, from AC mains to the battery) as the BC, or only the components downstream from the wall adapter (*i.e.*, from the charging base to the battery).

The interpretation of the BC definition, like the EPS definition, depends on the functionality of the wall adapter. If a wall adapter provides charge control, the battery charging system it powers cannot operate or be tested without it. On the other hand, if the wall adapter only provides power conversion, it can be modeled as a voltage source, and the battery charging system can be tested independently of the wall adapter. In this case, the wall adapter portion of the battery charging system could therefore be included or not included in the eventual BC standards.

3.2.3.1 Wall Adapters Specifically Excluded from Class A EPS Standards

The above discussion concerns battery charging functionality, and its use as a determinant for inclusion of wall adapters within the scope of BC and EPS standards. However, though a particular wall adapter may be considered an EPS based on its lack of charge control functionality, it may still be excluded from this rulemaking because the Class A definition presented in section 3.2.1 excludes EPSs used within specific kinds of battery charging systems.

In particular, any device that "powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated" is excluded. (42 U.S.C. 6291 (36)(C)(ii)(II)) EISA further defines a detachable battery as one that is "(A) contained in a separate enclosure from the product; and (B) intended to be removed or disconnected from the product for recharging." (42 U.S.C. 6291(52))

The second criterion in paragraph (36)(C)(ii)(II) is clear: any wall adapter that falls under the definition of EPS is excluded from current and future Class A EPS standards if it is part of a battery charging system used with a power tool or other motor-operated rechargeable product.

The meaning of the first criterion in paragraph (36)(C)(ii)(II) is less clear. The phrase "contained in a separate enclosure from the product," however, appears earlier in the Class A EPS definition, providing a potential interpretation. In that case, the definition limits Class A EPSs to devices "contained in a separate physical enclosure from the end-use product," *i.e.*, a separate component outside the physical boundaries of the end-use consumer product. (42 U.S.C. 6291(36)(C)(i)(IV))

Similarly, when applied to detachable batteries, this phrase can also be interpreted to mean "wholly outside the physical boundaries of the end-use consumer product." This is in contrast to batteries contained in an enclosure wholly or partly inside the physical boundaries of the end-use consumer product (*e.g.*, inside a battery compartment).

A further constraint on the definition of detachable batteries is the requirement that they be "intended to be removed or disconnected from the product for recharging." (42 U.S.C. 6291(52)(B)) Thus, even if a battery is not contained inside the product, it may not be considered "detachable" unless it is also intended to be "removed or disconnected from the product."

In particular, several popular models of camcorders employ wall adapters that can be used to power the camcorder and charge its battery.[10] However, even though these batteries are not contained inside the product, it is not necessary to remove them for charging. Rather, the wall adapter plugs directly into the camcorder body or into a cradle that accepts the entire camcorder. Therefore, DOE does not consider these batteries detachable and does not consider the wall adapters for these camcorders to be excluded from the Class A EPS definition per 42 U.S.C. 6291(36)(C)(ii)(II).

Other than camcorders, DOE has not identified any end-use consumer products with batteries that are not contained inside the product that are not also "fully or primarily motor operated." Therefore, DOE considers only the wall adapters for motor operated products (*e.g.*,

[10] The Sony Handycam HDR-TG1 and the Canon Vixia HF10 are two examples.

rechargeable power tools and household appliances) to be excluded from the Class A EPS definition and the scope of Class A standards.

Item 5 *DOE welcomes comment on any products with detachable batteries that are not motor operated, the wall adapters of which should also be excluded from Class A EPS standards.*

Finally, it is worth noting that there are no electrical differences between the two battery arrangements (*i.e.*, wholly outside versus wholly or partly inside the end-use product). As a result, there is no explanation why charging one type of battery would require the associated EPS to be excluded from Class A, while charging another type would not. Nonetheless, DOE believes that excluding EPSs that charge batteries wholly outside the physical boundaries of the end-use consumer product is more appropriate in the context of the language in 42 U.S.C. 6291 (36)(C)(ii)(II).

Item 6 *DOE requests comment on its interpretation of the definition of "detachable battery," and the impact on EPSs excluded from Class A.*

3.2.3.2 Key Questions

The above discussion of how to treat wall adapters when used with battery charging systems can be reduced to two key questions. The answers to these two questions will determine whether DOE will treat a particular wall adapter as an EPS, a part of a BC, both, or neither, and will determine which components of a battery charging system are subject to which test procedure (BC or EPS) and which standard they must meet.

Question 1: Should a wall adapter that powers a battery charging system be considered an EPS? Based on the answer to this question, DOE will determine whether to test the wall adapter to meet the requirements of an EPS energy conservation standard. There are three possible answers to this question:

(1) A wall adapter that powers a battery charging system is always considered an EPS.
(2) A wall adapter that powers a battery charging system is considered an EPS only if it does not perform a charge control function.
(3) A wall adapter that powers a battery charging system is never considered an EPS.

Table 3.1. Treatment of Different Types of Wall Adapters That Power a Battery Charging System Spending on the Answer to the First Key Question

	Q1: Should the wall adapter be considered an EPS?		
	(1) Always	(2) Only if no charge control	(3) Never
Wall Adapter Without Charge Control Functionality	EPS	EPS	Not EPS
Wall Adapter with Charge Control Functionality	EPS	Not EPS	Not EPS

Question 2: Should the wall adapter that powers a battery charging system be considered part of the BC? There are two possible answers to this question:

(1) A wall adapter that powers a battery charging system is always considered part of the BC.
(2) A wall adapter that powers a battery charging system is considered part of the BC only if it performs charge control functions.

Based on the answers to these questions, DOE will determine which components of a battery charging system will have to meet the requirements of a possible BC energy conservation standard.

Table 3.2. Treatment of Different Types of Wall Adapters That Power a Battery Charging System Depending on the Answer to the Second Key Question

	Q2: Should the wall adapter be considered part of the BC?	
	(1) Always	(2) Only if charge control
Wall Adapter Without Charge Control Functionality	BC	Not BC
Wall Adapter with Charge Control Functionality	BC	BC

3.2.3.3 Possible Approaches to Interpreting the Definitions of BCs and EPSs

The answers to each of the key questions presented above can be combined in several different ways to fully describe the treatment of wall adapters that power battery charging systems. These combinations of answers are summarized as one of four possible "Approaches," which are presented in Table 3.3.

Table 3.3. The Answers to the Key Questions Are Combined to Form Four Distinct Approaches to Dealing with Wall Adapters That Power Battery Charging Systems

		Q2: Should the wall adapter be considered part of the BC?	
		(1) Always	(2) Only if charge control
Q1: Should the wall adapter be considered an EPS?	(1) Always	Approach D	Approach not evaluated.*
	(2) Only if no charge control	Approach A	Approach C
	(3) Never	Approach B	Approach not evaluated.**

* DOE will not evaluate this approach further because it would result in too many additional product classes as discussed under section 3.2.3.7, Details of Approach D.
** DOE will not evaluate this approach further because it would require granting an exclusion from Class A EPS standards that is inconsistent with EISA (see section 3.2.3.5) and would leave some wall adapters entirely outside of the scope of the BC and Class A EPS rulemakings.

Figure 3.8 and Figure 3.9 illustrate all the mains-powered product configurations that are within the scope of the BC and Class A EPS rulemakings. One of the four approaches, described abstractly in Table 3.3, will be applied to each of these configurations during this rulemaking. In particular, the key questions presented above concern the middle configurations (Configurations 2–10) in the two figures, which include a wall adapter that powers a battery charging system. Configuration 1 in Figure 3.8 lacks a battery charging system, and is therefore outside the scope of this discussion, but was included for the sake of completeness. Similarly, Configurations 11–13 in Figure 3.9 lack wall adapters, so, as described in section 3.2.2 there is no question that they would be considered BCs in their entirety.

Because the configurations are similar, with differences only in battery packaging and charger interface, it is useful to focus on the distribution of functions within the system. Figure 3.10 illustrates the four approaches as they apply to generalizations of the product configurations presented in Figure 3.8 and Figure 3.9; the details of charger, cradle, and battery have been removed while the distributions of functions between the wall adapter and the rest of the system have been retained. The following sections detail the advantages and disadvantages of the four approaches.

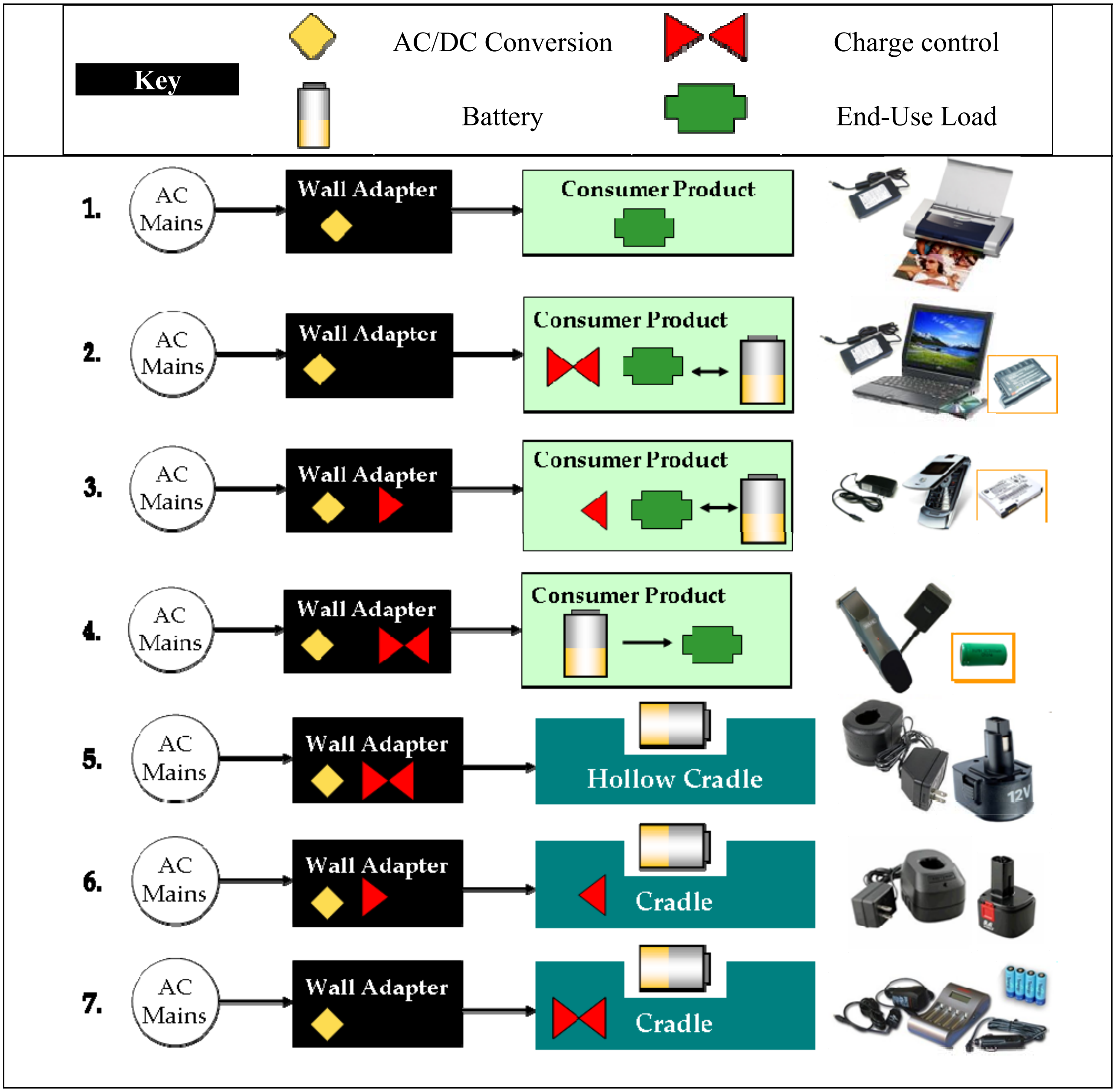


Figure 3.8. Configurations of Power Conversion and Battery Charging Functions in Consumer Products

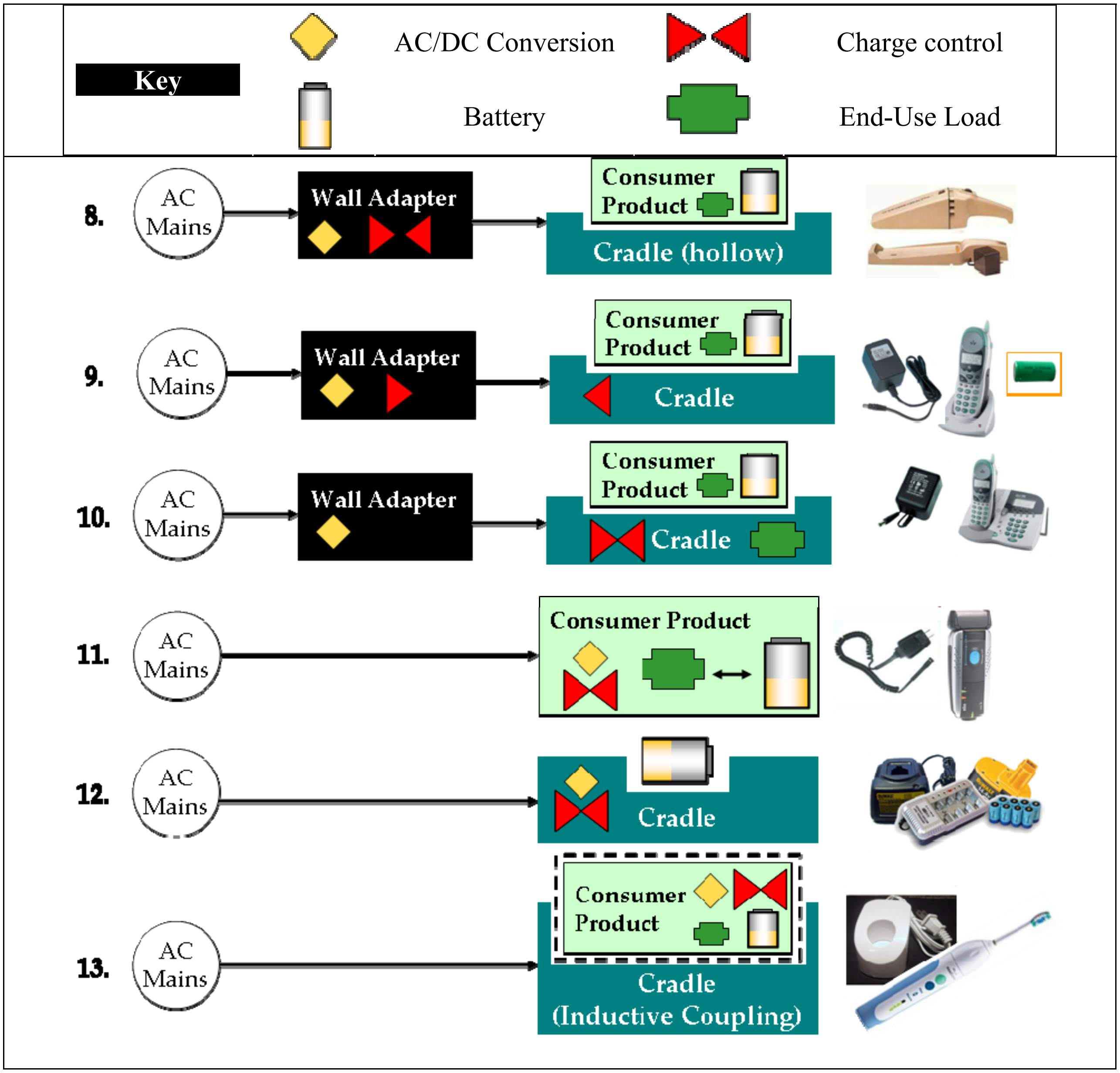


Figure 3.9. Configurations of Power Conversion and Battery Charging Functions in Consumer Products (Continued)

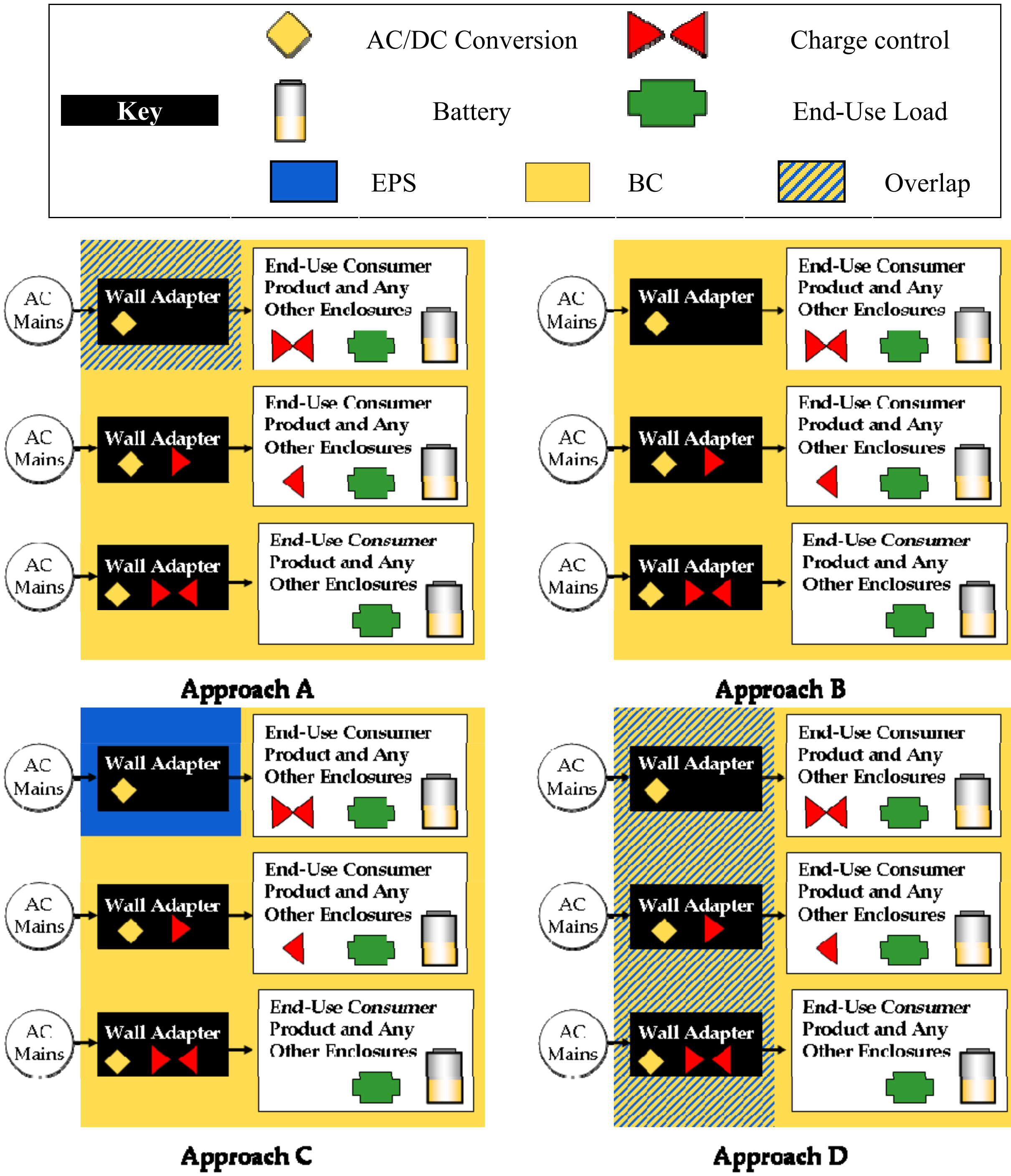


Figure 3.10. Comparison of How Various Battery Charging Systems Would Be Treated Under Each of the Four Approaches. The charge control function can be split between enclosures. Enclosures covered by the "overlap" would be considered to be subject to both BC and EPS standards.

3.2.3.4 Details of Approach A

Under Approach A, illustrated in Figure 3.10, DOE would:

- only consider a wall adapter that powers a battery charging system to be an EPS if it does not perform a charge control function;
- always consider the wall adapter to be part of the BC; and
- potentially establish two standards: one for the wall adapters that perform only power conversion and one for all components of the BC system.

The July 1, 2008, EISA standard levels were based on efficiency levels used by ENERGY STAR and at least 9 States and the District of Columbia. Their EPS efficiency programs, however, limited their scopes to wall adapters providing only power conversion functions,[11] so the standards these programs—and subsequently Congress—adopted were developed specifically for these types of wall adapters. By adopting Approach A, which would harmonize with these prior programs, DOE would be ensuring that the current Class A EPS standards apply to all the wall adapters for which they were originally developed.

For the purposes of describing BCs, this approach considers the entire battery charging system—from wall plug to battery—to be a BC. Any wall adapter that powers a battery charging system is a component of "a device that charges batteries for consumer products"—*i.e.*, a BC—even if it is also considered an EPS and subject to EPS standards. (42 U.S.C. 6291(32)) Under this approach some battery charging systems would be subject to two standards: a BC standard for the battery charging system as a whole—from wall plug to battery—and an EPS standard specifically for the wall adapter. EISA permits this possibility since it provides that "an energy conservation standard for external power supplies shall not constitute an energy conservation standard for the separate end-use product to which the external power supply is connected." (42 U.S.C. 6295(u)(4))

Because Approach A would treat only wall adapters without charge control as EPSs, all devices subject to the EPS standards analysis would provide similar utility as constant-voltage sources. As a result, all EPSs could be held to a consistent set of standards, requiring no additional product classes (see section 3.6.2). Likewise, DOE expects the product-class divisions within the BC analysis to be straightforward because under this interpretation of the BC definition, all components of a battery charging system would be included in the standards analysis—extending from the wall plug to the battery. Thus, all AC mains-powered BCs would contain the same circuit functions—whether they are located within the consumer product, charging cradle, or wall adapter—and could be included within the same overarching product class before being separated by output voltage as described in section 3.6.1. An additional product class would be required to analyze DC-powered BCs.

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[11] The ENERGY STAR and State programs specifically exclude wall adapters that "have batteries or battery packs that physically attach directly" or "have a battery chemistry or type selector switch AND an indicator light or state of charge meter." (EPA. "ENERGY STAR Program Requirements for Single-Voltage External Ac-Dc and Ac-Ac Power Supplies: Eligibility Criteria." Version 1.1 (emphasis in original).) These exclusions would apply to wall adapters with battery charging functions.

However, this approach would also introduce some overlap between the BC and EPS definitions, which would affect DOE's analysis. Because certain wall adapters would be considered both EPSs and components of BC systems, the potential for energy savings may have to be analyzed sequentially. First, an economically justified and technologically feasible standard level would have to be developed for the wall adapter during the EPS analysis. Then, given a wall adapter that meets a particular EPS standard level, an economically justified and technologically feasible standard level would have to be developed for the system as a whole.

As a result, a separate product class may have to be created to accurately analyze BCs powered by wall adapters that are also considered EPSs. However, based on testing and discussions with manufacturers, DOE believes that the majority of wall adapters used for battery charging applications have charge control functions, leaving only a small percentage of these wall adapters that would be considered EPSs under Approach A.[12]

An added complication of the overlap between BC and EPS standards is the possibility that future EPS standards may impose a design constraint resulting in lower cost-justified energy savings than a single system-wide BC standard. This is because complying with future EPS standards may prevent implementing cost-justified energy efficiency improvements in the remainder of the BC system. (DOE would need to evaluate the likelihood of this possibility.) Furthermore, a general EPS analysis of a wall adapter independent of the battery charging system it powers would not fully account for the loading and usage of the battery charger as accurately as a dedicated battery charging system analysis.

This problem could, however, be mitigated through the addition of product classes specifically for BCs powered by EPSs. By placing these products in a separate product class, DOE could exempt the wall adapters from additional EPS standards beyond those required by EISA, resulting in only one new system-wide BC standard. DOE may decide to exempt products in this class from additional EPS requirements beyond EISA, based on consideration of the seven EPCA factors (see section 1.2.2), particularly given the potential for additional cost-justified EPS energy savings and an analysis of burdens on the manufacturer. A single system-wide standard for BCs powered by EPSs could result in higher cost-justified energy savings.

Finally, Approach A would require manufacturers to qualify and certify some wall adapters as compliant with EPS standards and subsequently re-qualify the entire battery charging system powered by the wall adapter as compliant with BC standards. However, as mentioned above, DOE does not believe that a significant number of battery charging systems use wall adapters that would be considered EPSs under Approach A. Futhermore, DOE does not expect the absolute duration of the qualification process to increase, as manufacturers should be able to qualify the wall adapter and the entire battery charging system in parallel, if the wall adapter is not already qualified under EISA.

[12] Furthermore, many battery charging systems powered by wall adapters either have detachable batteries or are "fully or primarily motor operated" and, therefore, are not subject to the EISA EPS standards. DOE is currently analyzing whether an energy conservation standards rulemaking should be conducted for these products.

Nonetheless, even if qualification and certification are conducted in parallel, adopting this approach could double the testing and documentation burden on manufacturers compared to a single system-wide BC standard (*e.g.*, as under Approach B). Similarly, in cases where manufacturers outsource the design and production of the BC wall adapter, these compliance costs would affect the final cost of the product. This burden could be reduced if DOE places BCs powered by EPSs into a separate product class, as described above.

Nonetheless, because of its consistency with the ENERGY STAR and State approaches, its inclusion of a large number of wall adapters under the current EISA EPS standards, and the possibility of reducing manufacturer compliance burdens, DOE believes that the benefits of Approach A outweigh the disadvantages. Accordingly, DOE proposes Approach A as its preferred approach.

To summarize, under this approach, DOE would only consider wall adapters that do not perform a charge control function to be EPSs, while it would consider all wall adapters to be part of the BC, even if they are also considered EPSs. The advantages of this approach are that:

- it is consistent with the ENERGY STAR and State interpretations of EPS definition and testing of products;
- it provides the second greatest scope of coverage and savings for current EPS standards (equal to Approach C, second to Approach D); and
- it provides for an overall battery charging system standard (in addition to the EPS standard for some wall adapters) such that the system is tested in a manner similar to how it is operated.

The disadvantages of this approach are that:

- it subjects BC manufacturers using wall adapters without charge control to both EPS and system-wide BC standards, potentially increasing compliance burden; and
- it may result in lower cost-justified energy savings than a single system-wide BC standard (unless certain wall adapters are exempted from EPS standards beyond EISA);

3.2.3.5 Details of Approach B

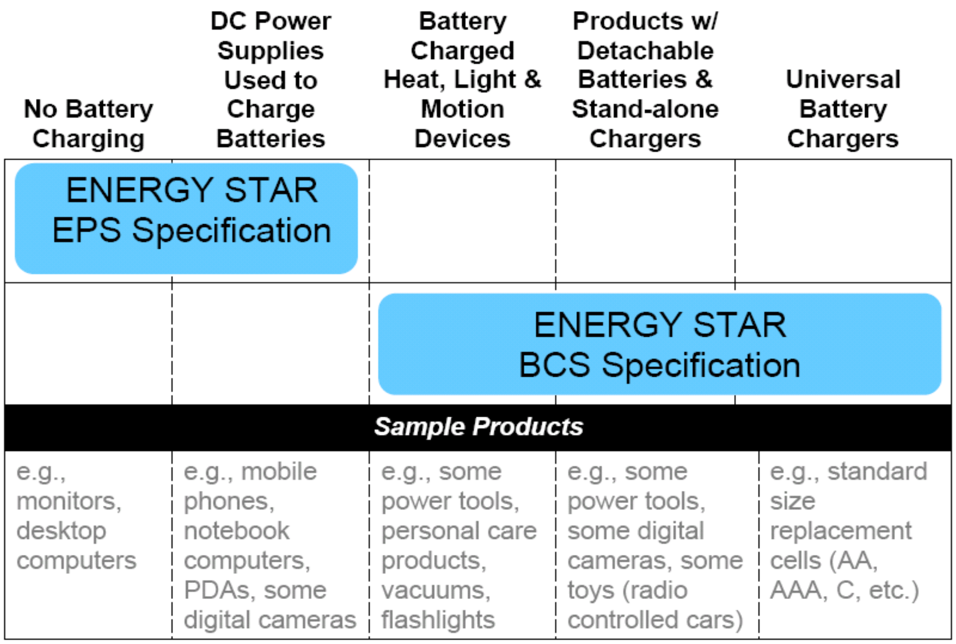
Under Approach B, illustrated in Figure 3.10, DOE would:

- never consider a wall adapter that powers a battery charging system to be an EPS;
- always consider the wall adapter to be part of the BC; and
- potentially establish separate BC standards for the battery charging system and EPS standards for wall adapters that do not power battery charging systems.

This approach is based in part on the EPA ENERGY STAR "heat, light, and motion" approach[13] used to differentiate between EPSs and BCs that DOE initially considered adopting wholecloth. Under this ENERGY STAR approach, a product is classified as either a BC or EPS,

[13] EPA. "ENERGY STAR Program Requirements for Products with Battery Charging Systems: Eligibility Criteria."

but not both.[14] Qualifying devices under the BC category are further limited to (1) chargers packaged with "products whose principal output is mechanical motion, light, the movement of air, or the production of heat," and (2) stand-alone chargers for removable and standard-size alkaline-battery replacement batteries. The ENERGY STAR approach is illustrated in Figure 3.11.



Source: U.S. EPA, 2009.

Figure 3.11. EPA ENERGY STAR Division Between Products Qualifying Under the EPS and BC Specifications. This division is similar to that under consideration in Approach B.

The ENERGY STAR approach eliminates overlap between the BC and EPS categories and would potentially reduce the compliance burden on manufacturers while resulting in higher economically justified energy savings. The ENERGY STAR BC and EPS divisions, however, conflict with the statutory BC definition, which is not limited to chargers used for heat, light, and motion products or stand-alone chargers. Consequently, when considering the scope set out in the statutory definition of a BC, DOE has determined that the ENERGY STAR Program approach is too narrow and would not permit DOE to satisfy its legal obligations under the statutory framework laid out by Congress.

To address these shortcomings, DOE developed Approach B, which is similar in structure to the ENERGY STAR approach, but attempts to address the coverage issues presented by the statutory BC definition. Like the ENERGY STAR approach, Approach B results in no overlap between BC and EPS standards. But in contrast to ENERGY STAR, all components of the battery charging systems for every application are considered BCs, not just chargers for heat, light, and motion applications.

[14] EPA defines EPSs in terms similar to those used in section 301 of EISA to define Class A EPSs. (42 U.S.C. 6291(36)(C)(i))

Under this broader reading of the BC definition, the scope of the BC standard would include battery chargers embedded in products such as cellular telephones and laptop computers. The wall adapters of these products have been considered to be EPSs by the ENERGY STAR program and the ten States that have adopted EPS definitions and standards based on ENERGY STAR.[15]

However, to prevent an overlap between BC and EPS standards, these wall adapters would not be considered EPSs under Approach B. Instead, DOE would interpret the phrase "consumer product" in the EPS definition to exclude devices already regulated separately under the BC standard. Although this interpretation would clarify the ambiguities in the BC and EPS definitions and resolve the issues with overlapping regulation raised by Approach A, it would result in a smaller scope of coverage for the current Class A EPS standards than Approaches A, B, and C, and may not be consistent with some additional requirements contained in EISA.

Specifically, DOE cannot limit the scope of the EPS definition by adding another exclusion to those already created by Congress. Section 301 of EISA amended section 321 of EPCA by inserting a definition for Class A EPSs. In addition to defining a Class A EPS, EISA also created two specific exclusions for products that would otherwise be considered Class A EPSs. EISA excludes "any device that . . . powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated." (42 U.S.C. 6291(36)(C)(ii)) This exclusion limits its scope to those devices that (1) power the charger of a detachable battery pack or (2) charge the battery of a product that is fully or primarily motor operated. Congress did not authorize DOE to add to these exclusions.

Given these specific statutory exclusions, and the absence of any statutory authority to add to these exclusions, DOE cannot create additional exclusions for Class A EPSs beyond those that Congress already created. Nonetheless, DOE has included this approach in the discussion because of its similarity to the accepted ENERGY STAR approach and potential for lower compliance burdens on manufacturers.

Item 7 *DOE welcomes comment on ways of amending Approach B to make it consistent with the statutory language in EISA, or proposals of alternate approaches based on the clear BC and EPS divisions of the ENERGY STAR program.*

In this context, it is worth emphasizing the possibility of creating a separate product class for wall adapters that power battery charging systems but that provide no charge control functions (and would therefore be considered EPSs under Approach A). See section 3.2.3.4, above. By placing these types of wall adapters into a product class separate from wall adapters

[15] To date, none of the states have adopted standards for BCs, and only one—California— has adopted a test procedure. Furthermore, none of the states have issued guidelines on delineating BCs and EPSs.

for other applications, these wall adapters could be subject only to future BC standards as components of a BC system.

Treating wall adapters in this manner, Approach A becomes similar to Approach B and the ENERGY STAR approach, by removing overlap between future BC and EPS standards since only wall adapters for non-battery charging applications would be potentially subject to amended EPS standards. Similarly, wall adapters that are part of a battery charging system—together with any other enclosures that include the charge-control circuitry—would only be subject to a system-wide BC standard. Therefore, there would be no overlap between the scope of the two standards.

The benefits of this elaboration to Approach A, as opposed to Approach B, are that it is consistent with the statute and would result in a larger number of wall adapters currently subject to the Class A EISA EPS standards, and greater immediate energy savings.

Despite the advantages of Approach B, DOE will be unable to adopt this and similar approaches due to their exclusion of wall adapters that power battery charging systems from current EPS standards. Were it possible to implement it, the advantages of Approach B would be that:

- it eliminates overlap between the scopes of EPS and BC standards, limiting manufacturer burden of complying with one standard for both manufacturers of individual components and the entire BC-EPS system; and
- it provides broadest scope for system-wide BC standard (all components of battery charging systems), resulting in maximum economically justified energy savings.

The disadvantages of Approach B would be that:

- it is inconsistent with the EISA definition of Class A EPSs;
- it excludes wall adapters for applications such as laptops and cell phones from EPS standards, contrary to ENERGY STAR and State precedent; and
- it provides the smallest scope of coverage and savings for current EPS standards, by interpreting the EPS definition to exclude any wall adapter that powers a battery charger, including applications such as laptops and cell phones.

3.2.3.6 Details of Approach C

Under Approach C, illustrated in Figure 3.10, DOE would:

- consider a wall adapter that powers a battery charging system to be an EPS only if it does not perform charge control functions;
- consider the wall adapter to be part of the BC only if it performs charge control functions; and
- establish separate EPS standards for some wall adapters and BC standards for the remainder of the components of the battery charging system.

Approach C is similar to Approach A in its interpretation of the EPS definition; however, its interpretation of the BC definition is different. Under Approach C, DOE would interpret the EPS definition to include all wall adapters that perform no charge control functions. However, the Department would interpret the definition of a BC to apply only to battery charging system components intended exclusively for battery charging. This interpretation would therefore consider a wall adapter that powers a battery charging system to be part of the BC only if it performs charge control functions.

Like Approach A, Approach C would apply EPS standards only to wall adapters that perform no charge control functions, which would harmonize this approach with the ENERGY STAR and State approaches. Approach C would, however, eliminate overlap between BC and EPS standards because a wall adapter that does not perform charge control function would not be considered as part of the BC. As a result, components of the same battery charging system could be subject to two separate, but disjointed, standards: an EPS standard for wall adapters with no charge control functions, and a BC standard for the remaining components of the BC system. Like Approach A, Approach C would subject all wall adapters currently within the scope of the ENERGY STAR program to the current Class A EISA standards, providing the second greatest scope of coverage for current standards.

Even though there is no overlap between the EPS and BC standards under Approach C, applying separate standards to components of a system may still result in higher manufacturer burden and lower economically justified energy savings than a single, system-wide standard. Manufacturers of a single product would have to comply with two efficiency standards on different components of the product, while an analysis conducted under approach C would ignore any technology options that rely on the interaction between two components considered BCs and EPSs, respectively, to produce energy savings. Furthermore, by including the wall adapter within the scope of the general EPS standards analysis, it is not possible to account fully for the particular load presented by the battery charging system, since the application of the generic EPS loading conditions and usage profiles may not be completely representative of BC loads.

Finally, unlike Approach A, there is no way to mitigate these concerns since Approach C's definition of BC does not include the wall adapter, DOE cannot exclude wall adapters for BCs from possible future EPS standards, while subjecting them only to system-wide BC standards.

Approach C also requires additional product classes. Unlike Approaches A and B, where the interpretation of EPS and BC definitions placed similar types of products within the scope of EPS and BC standards, under Approach C, the BC standard would include two distinct types of battery chargers. The first class of BCs, using an internal power supply or wall adapter with charge control circuitry for power conversion, would be tested with the power supply, and its presence would be reflected in the efficiency test results. In contrast, the second class, utilizing a voltage-source wall adapter subject to EPS standards, would be tested without the wall adapter to prevent overlap between the standards, which means that the power supply would not be included in the test results. Accordingly, the energy consumption of the two classes would not be directly comparable, requiring the use of separate standards.

To conclude, Approach C is similar to Approach A in that the definition of EPS is interpreted to include only wall adapters without charge control. It differs in its interpretation of the BC definition, which includes the wall adapter if it contains charge control functionality. The advantages of this approach are that:

- it is consistent with the ENERGY STAR and State interpretation of the EPS definition and testing of products; and
- it provides the second greatest scope of coverage and savings for current EPS standards (equal to Approach A, second to Approach D).

The disadvantages of this approach are that:

- like Approach A, it subjects components of battery charging system powered by a wall adapter without charge control to EPS and BC standards, potentially increasing compliance burden for manufacturers of the entire BC-EPS system; and
- like Approach A, it will result in future equal or lesser cost-justified energy savings than a single-system-wide BC standard for BCs powered by EPSs.

3.2.3.7 Details of Approach D

Under Approach D, illustrated in Figure 3.10, DOE would:

- always consider a wall adapter that powers a battery charging system to be an EPS;
- always consider the wall adapter to be part of the BC; and
- potentially establish two standards: one for wall adapters and one for the BC system as a whole.

Unlike the previous approaches, which considered the circuit function when determining whether a component of a battery charging system should be subject to the EPS or potential BC standard, Approach D takes into account only the physical characteristics of the device. An EPS "converts household electric current into DC current or lower-voltage AC current," and in the discussion of Approaches A and C, DOE indicated that this clause can be interpreted to exclude wall adapters that perform charge control functions and are intended solely to charge batteries (sections 3.2.3.4 and 3.2.3.6). However, one could also view wall adapters as providing charge control functions *in addition* to converting household current into lower voltage DC current and should therefore be considered EPSs.

Further, while the EISA definition of a Class A power supply is modeled on the ENERGY STAR EPS definition, it contains a significant difference. Whereas the ENERGY STAR EPS definition excludes devices that "have batteries or battery packs that *physically attach directly* . . . to the power supply unit,"[16] the EISA Class A definition does not. Because the EISA definition omits this exclusion, wall adapters that "physically attach directly" to the

[16] EPA. "ENERGY STAR Program Requirements for Single-Voltage External Ac-Dc and Ac-Ac Power Supplies: Eligibility Criteria." Version 1.1 (emphasis added).

battery may now be considered as Class A EPSs. These wall adapters, however, are equipped with charge control, which is necessary when the wall adapter is connected directly to the battery to limit the charge current and prevent overheating. Therefore, the removal of the above exclusion from the EISA Class A EPS definition seems to imply that EPSs with charge control functionality could be included under the definition of Class A EPSs and therefore EPSs in general. This would expand the scope of coverage of current Class A EISA standards to all wall adapters, not just those that have been considered EPSs under ENERGY STAR.

Under Approach D, all components of a battery charging system would be considered within the scope of the BC definition, similar to Approach A. This interpretation would likewise cause overlap between BC and EPS standards, with wall adapters that power battery charging systems considered both EPSs and components of BCs. Similarly as under Approaches A and C, this overlap may result in a higher compliance burden and lower cost-justified energy savings than achievable under single, system-wide BC standards.

Also, because wall adapters with and without charge control would be considered EPSs, these two types of devices would need to be grouped into separate overarching product classes and be subject to two different standard levels. This would be necessary because wall adapters with charge control provide additional utility and may not be able to meet the same standard levels as wall adapters without charge control.

Thus, although Approach D would facilitate the differentiation between BCs and EPSs by allowing quick visual inspection, differentiating wall adapters based on charge control function cannot be eliminated entirely and would complicate the downstream analysis and potential EPS standards.[17]

By modifying Approach D to exclude wall adapters without charge control function from the scope of the BC definition, DOE could decrease the number of wall adapters potentially subject to both BC and EPS standards. Under this alternate approach, all wall adapters would be considered EPSs, but wall adapters without charge control would not be subject to BC standards. DOE did not consider this alternate approach because it would further add to the product classes required under Approach D, as separate standards for wall adapters with and without charge control would be needed as well as separate standards for BCs powered by wall adapters with and without charge control.

However, the complications may go beyond separate product classes and standard levels—some wall adapters with charge control may not be testable under the EPS test procedure. As presented in Figure 3.7, some wall adapters for battery charging applications provide a constant current, rather than a constant voltage. This constant current varies from unit to unit due to manufacturing tolerances, such that a particular unit may not be able to deliver its nameplate current. Under these conditions, a manufacturer may not be able to test a wall adapter with charge control under the EPS test procedure, which requires loading the unit to 100 percent of its nameplate current, further complicating the implementation of Approach D and any similar approaches.

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[17] Differentiating wall adapters based on charge control function would require testing of output current and voltage under load, as described in section 3.2.4.

Item 8 *DOE seeks comment on the prevalence of wall adapters for battery charging applications that may not be testable under the EPS test procedure.*

To summarize, under Approach D, all wall adapters would be considered EPSs, while all components of a battery charging system, including those wall adapters that are considered EPSs, would be considered BCs. There would be significant overlap between the two definitions and scopes of potential standards. The advantages of this approach are that:

- it simplifies identification of EPSs by relying solely on physical characteristics; and
- it provides the greatest scope of coverage and savings for current EPS standards, because it considers all wall adapters (even those with charge control) to be EPSs and therefore subject to the current EISA standards.

The disadvantages of this approach are that:

- it subjects wall adapters without charge control that power battery charging systems to both EPS and system-wide BC standards, potentially increasing the compliance burden for manufacturers of individual components as well as the entire BC-EPS system;
- it may result in lower cost-justified energy savings than a single, system-wide BC standard (unless certain wall adapters are exempted from EPS standards beyond EISA);
- it may lead to complications associated with testing wall adapters that perform charge control according to the EPS test procedure;
- it would result in additional product classes and potential standard levels; and
- it is inconsistent with ENERGY STAR and State interpretation of EPS definition and product testing.

3.2.3.8 Summary of the Four Approaches

DOE evaluated the above four approaches based on the desirable criteria presented in Table 3.4, assigning a "+" (advantage), "0" (neutral), or "–" (disadvantage), depending on how well the approach met each criterion.

Table 3.4. Comparison of the Four Approaches to Interpreting the BC and EPS Definitions Against Desirable Characteristics

Criterion	Approach A	Approach B	Approach C	Approach D
Is consistent with the EISA Class A EPS definition	+	–	+	+
Provides a broader scope of coverage for current EPS standards	0	–	0	+
Results in higher cost-justified energy savings	0	+	–	0
Subjects manufacturers to lower compliance burdens	–	+	–	–
Results in fewer potential product classes	+	+	0	–
Is consistent with ENERGY and State EPS efficiency	+	0	+	0

Criterion	Approach A	Approach B	Approach C	Approach D
programs				
Provides a BC definition that encompasses entire battery charging system	+	+	0	+

Item 9 *DOE seeks comments on the four approaches to interpreting the BC and EPS definitions to resolve ambiguities in the scope of the analyses. DOE is also interested in determining whether Approach B could be modified to permit its use in a manner consistent with the statutory framework created by Congress.*

Item 10 *DOE welcomes comment on additional functionality provided by some wall adapters for battery chargers that may impede their ability to meet the same standards as comparable wall adapters for other applications. DOE asks that commenters provide specific examples and suggest ways in which DOE can address any potential barriers that may arise.*

Item 11 *DOE welcomes comment on the manufacturer burden of compliance with current EISA Class A EPS standards under each of the four approaches and seeks information on how DOE can minimize this burden while ensuring that the standards are being met consistently by the industry.*

Item 12 *DOE also welcomes comment on the likely manufacturer burden of compliance with possible future EPS and BC standards under each of the four approaches. To this end, DOE also seeks information from the industry regarding how the monitoring of compliance with these standards can be accomplished.*

3.2.4 Identification of Wall Adapters

The above approaches depend on identifying whether wall adapters that power battery charging systems also perform charge control functions, a task that is not always straightforward. To aid in this process, DOE is considering the adoption of three possible criteria to help identify those wall adapters that perform charge control functions:

(1) *Short-circuit operation*: How the wall adapter performs when a short-circuit load is applied.
(2) *Voltage regulation*: How the output voltage of the wall adapter varies at different active mode loading conditions relative to the nameplate output voltage.
(3) *No-load voltage*: How the output voltage of the wall adapter varies at no load relative to the nameplate output voltage.

Short-circuit operation is important to battery charging because a fully discharged battery connected to a battery charging system approximates a short circuit. The battery charger must be designed to operate in this condition. It cannot cut off current to the battery completely, but must provide sufficient current for the battery to charge safely. For wall adapters without charge control that do not connect directly to batteries, a short circuit is an abnormal fault condition. In that case, the wall adapter may cut off all current to the output through a fuse or other protective element.

In addition to short-circuit operation, DOE is considering voltage regulation and no-load voltage as possible criteria for determining the presence of charge control functions and the placement of a particular wall adapter within the scopes of the BC and EPS definitions under the four approaches. A wall adapter for non-battery charging applications is a voltage source that ideally provides constant output voltage with variable output current. In contrast, battery charging requires a current source that provides constant current with variable output voltage.

However, some line-frequency wall adapters that are not used in battery charging applications tend to have poor voltage regulation,[18] which limits the usefulness of this criterion because their voltage regulation and no-load voltage might be similar to that of a wall adapter that performs charge control.

Item 13 *DOE is seeking input on these and any additional criteria it should consider in determining the presence of wall adapter charge control functions.*

DOE is also considering requiring identification labels to easily differentiate between wall adapters that perform charge control functions and those that do not, as identified using criteria such as those listed above. Manufacturers could be required to label a wall adapter based on whether it performs charge control functions. Under Approaches A and C, this label would determine whether the wall adapter should be subject to an EPS standard or should be considered as part of the entire battery charging system, and therefore subject to a BC standard. Under Approach D, this label would determine which EPS product class a wall adapter belongs to, and therefore, which standard it may be required to meet. In any case, the label would serve only to expedite standards enforcement; because labeling is vulnerable to manipulation, DOE would also need to check whether the correct label has been applied through the more extensive tests noted above.

Item 14 *DOE welcomes comment on external characteristics (either physical or electrical) that can be used to identify a wall adapter performing charge control for determining compliance with the appropriate standard under Approaches A, C, and D, as well as the use of labeling to permit easy identification. How likely would it be that those requirements would be subject to potential manipulation by manufacturers? If manipulation is possible, what form, and in what context, would these activities likely occur?*

[18] "Regulation" refers to the dependence of output voltage on output current. Ideal voltage sources have excellent voltage regulation, meaning the voltage does not vary significantly with output current.

3.3 Market Assessment

DOE will qualitatively and quantitatively characterize the structure of the markets for BCs and EPSs. In the market assessment, DOE will identify and characterize the manufacturers of this equipment, estimate market shares and trends, address regulatory and non-regulatory initiatives intended to improve the efficiency or reduce the energy consumption of BCs and EPSs, and explore the potential for technological improvements in the design and manufacturing of these products.

This market assessment will establish the context for the rulemaking, and it will serve as a resource to guide the analyses that follow. For example, DOE may use historical shipments and prices as an indicator of future shipments and prices. Similarly, DOE may use market structure data for the manufacturer impact analysis, as those data could be particularly useful for assessing competitive impacts.

DOE recognizes that there may be limited public information on national shipments, manufacturing costs, distribution channels, and manufacturers' market shares of BCs and EPSs. These types of data are important inputs to analyses that determine if energy conservation standards are economically justified and will result in significant energy savings. Therefore, DOE encourages interested parties to submit data pertaining to these areas of interest that would improve DOE's understanding of the BC and EPS markets. These data may be provided under a confidentiality agreement with DOE's contractors responsible for this part of the rulemaking analysis, namely Navigant Consulting, Inc. (NCI) and/or D&R International, Ltd. As with other DOE rulemakings, DOE's contractors will aggregate data provided by manufacturers and other organizations when preparing results for DOE's analyses. These aggregated results do not divulge the sensitive raw data from each interested party, but enable other parties to review and comment on the aggregated dataset.

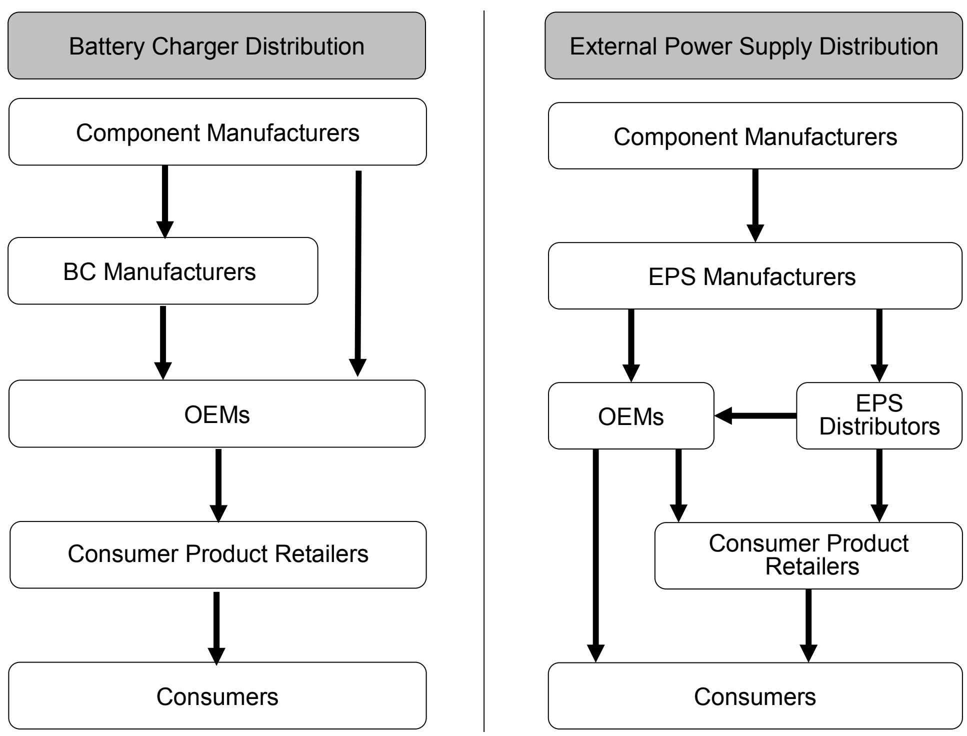
Alternatively, interested parties may submit confidential data to DOE, indicating in writing which data should remain confidential. To prevent public disclosure of the data as a result of third-party actions, interested parties providing confidential information to DOE must submit that data according to 10 CFR 1004.11. Under 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies. One copy of the document shall include all the information believed to be confidential, and the other copy of the document shall have the information believed to be confidential deleted. DOE will determine whether the information is confidential and treat it accordingly.[19]

[19] Factors of particular interest to DOE when evaluating requests to treat submitted information as confidential include the following: (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) a date upon which such information might lose its confidential nature due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

The following discussion reviews some aspects of DOE's market assessment developed during its 2006–2007 determination analysis, and presents approaches that DOE may use in the forthcoming preliminary analyses.

3.3.1 Distribution Channels

Figure 3.12 characterizes the physical distribution networks for BCs and EPSs that DOE examined during its initial work for the determination analysis. A component manufacturer sends components to a BC manufacturer, who assembles the BC. The BC manufacturer often ships the assembled device to a separate original equipment manufacturer (OEM). The OEM incorporates the BC into a consumer product and ships the entire package to a retailer, who sells it to the consumer. Alternatively, a single company could manufacture both a consumer product and the BC that charges it.



Sources: Calwell and Reeder, Manufacturer Incentives for Energy Efficient Power Supplies, 2002; Calwell and Reeder, Power Tools: A Hidden Opportunity for Energy Savings, 2002; Collon Lee, Astec Power, Personal Communication, 2006; Michael O'Connor and Michael Mueller, Phihong USA, Personal Communication, 2006; Power Tool Institute and Association of Home Appliance Manufacturers, DOE Scoping Workshop Transcript, January 24, 2007.

Figure 3.12. BC and EPS Distribution Networks

Item 15 *DOE welcomes comment on the possible differences in distribution channels between wall adapters used for battery charging applications that do and do not have charge control functions.*

Like BCs, EPS distribution also begins with component manufacturers. Unlike BCs, nearly all EPSs are built by EPS manufacturers. The EPS manufacturer will build either custom EPSs for an OEM or stock EPS models designed to work with a variety of consumer products. Stock products are manufactured according to popular designs that do not differ based on the application and then sold directly to OEMs or to EPS distributors. EPS distributors will then sell to retailers or OEMs. OEMs will bundle the EPS with a consumer product, and then sell to retailers or directly to consumers. One example of the latter is the direct-to-consumer sale of laptop computers.

3.3.2 Shipments

In section 2.2.1 of the associated draft technical report, DOE identifies four major trends that can affect shipments of BCs and EPSs over time. These trends are all related to the consumer products powered by BCs and EPSs.

- *Demand for Consumer Product Applications* refers to the changes in preferences, level of affluence, and population size that affect the demand for existing consumer product applications that use BCs or EPSs.

- *Convergence* means the application that uses an EPS is made redundant by another application. For example, mobile telephones increasingly incorporate the features of personal digital assistants (PDAs). As a result of convergence, some consumers may now have fewer devices than in the past, thus reducing the demand for BCs or EPSs.

- *Emergence* refers to the creation of new consumer product application categories—a critical factor, given the rapid pace of change in the consumer electronics market.

- *Substitution* means a shift between methods for supplying power to consumer products—internal power supplies, external power supplies, primary batteries, rechargeable batteries, Universal Serial Bus (USB) systems, and others.

Item 16 *DOE seeks comments on whether these and/or other factors influence the shipments of BCs and EPSs, and the extent to which each trend is likely to affect shipments.*

Although some data on the shipments of BCs and EPSs exist, DOE is also examining shipment information for applications that use BCs or EPSs. Application-level data are important in determining the growth rate of BC and EPS shipments (discussed in section 9) as well as the usage characteristics of these products (discussed in section 6). The following are the sources of shipment information DOE has identified to date. DOE will update these as newer information becomes available.

- *Appliance Magazine*. *30th Annual Portrait of the U.S. Appliance Industry*. September 2007.
- *Appliance Magazine*. *54th Annual Report: A Ten-Year Review 1997–2006 of the U.S. Appliance Industry*. May 2007.

- Consumer Electronics Association. *US Consumer Sales and Forecasts, 2003–2008*. July 2007. CEA: Arlington, VA.
- Darnell Group. *External AC-DC Power Supplies: Global Market Forecasts and Competitive Environment.* Second Edition. 2005. Darnell Group: Corona, CA.
- Information Technology Industry Council. *ITI PC Committee Projects Shipment Growth for 2007-2009.* September 2007. Information Technology Industry Council: Washington, DC.
- TIAX LLC. *Assessment of Analyses Performed for the California Energy Efficiency Regulations for Consumer Electronics Products*. February 2006. TIAX LLC: Cambridge, MA.
- Unpublished information provided by trade associations.

Tables 3.1 and 3.2 list the applications for which DOE was able to obtain shipment information. DOE intends to use the shipment data it has already collected for BCs and EPSs, as well as relevant new data. DOE invites submission of shipment data and specifically seeks data on applications not listed below. For a complete list of consumer product applications that use a BC or EPS and are considered in this rulemaking, please refer to section 2.3 of the draft technical report.

Table 3.5. BC-Powered Applications for Which DOE Has Shipment Data

Camcorders	Kitchen products
Digital cameras	Personal care products
Do-it-yourself (DIY) power tools	Professional power tools
Floor care products	Universal battery chargers

Table 3.6. EPS-Powered Applications for Which DOE Has Shipment Data

Camcorders	Notebook computers
Cordless telephones	Portable audio players
Digital cameras	Portable gaming devices
Flat panel monitors	Portable video players
Flatbed scanners	Small liquid crystal display (LCD) TVs
Ink-jet computer printers	Telephone answering devices
Local area network (LAN) equipment	Wi-Fi access points
Medical devices	Wireless telephones
Modems/fax modems	

Item 17 *DOE seeks input on shipment data for BCs and EPSs and the applications that use them, including applications that use non-Class A EPSs (section 3.6.2). DOE also seeks input on the percentage of applications that are shipped with either a BC or an EPS.*

3.3.3 Regulatory and Voluntary Programs

DOE has also identified several voluntary and regulatory programs within the United States and abroad that address the energy consumption of BCs and EPSs. Because the BC and EPS markets are global, these programs may affect the efficiency of BCs and EPSs sold in the United States, even in the absence of a similar Federal standard. For an overview of these programs, please refer to Appendix F of this document.

Item 18 *DOE invites interested parties to review and comment on domestic and foreign efficiency programs relating to BCs and EPSs.*

3.3.4 Market Failures

To prepare for its review under Executive Order 12866, "Regulatory Planning and Review," DOE will study market failures or other specific problems that may warrant agency action. DOE will assess the significance of any problem to determine whether a new regulation of BCs and EPSs is warranted. In its initial review of the market, DOE believes that there may be asymmetric information (one party to a transaction has better information than the other) regarding energy-efficiency opportunities in the BC and EPS markets. Battery chargers and external power supplies are generally bundled with the consumer product applications they power. Consumer purchasing decisions are based primarily on the merits of the end-use product and not the BC or EPS packaged with the product.

In most cases, the party responsible for deciding which BC or EPS to use with a particular application is not the consumer who pays the cost of operating it, but rather the OEM, who does not pay the cost of operation. OEMs may decide which BC or EPS to package with their product based on the manufacturing cost, not the efficiency of the unit. Because BCs and EPSs are often custom-designed for the application, the end user has little ability to choose a more efficient power source.

There may be certain external benefits resulting from the improved efficiency of BCs and EPSs that are not captured by users of these devices. These include both environmental and energy security-related effects that are not already reflected in energy prices, such as reduced emissions of greenhouse gases and reduced use of natural gas and oil for electricity generation. DOE seeks comments on the weight DOE should give to these factors when considering the maximum efficiency at which the total benefits are likely to exceed the total costs resulting from a new standard level.

Item 19 *DOE seeks comments and data from interested parties on these and other potential market failures that may apply to BCs and EPSs.*

3.4 Technology Assessment

The technology assessment focuses on understanding how the product uses energy and how efficiency measures can reduce the energy consumption of the BC or EPS. Measures that improve the energy efficiency of the product are called technology options. These are based on commercially available technologies as well as prototype designs and concepts. In consultation with interested parties, DOE will develop a list of technology options for consideration in this rulemaking. Following research into this list of technology options, DOE will consider each option against four screening criteria: technological feasibility; practicability to manufacture, install, and service; adverse impacts on product utility or availability; and adverse impacts on health or safety. (See section 4 for a discussion of these screening criteria.) Technology options that pass the four screening criteria are called design options and will be considered as appropriate ways of improving the efficiency of the product in the engineering analysis.

Unlike other products regulated under the DOE Appliances and Commercial Equipment Standards Program, BCs and EPSs do not provide an end-user function, but rather serve to provide power to consumer products. EPSs convert household AC power to lower-voltage AC or DC power required by electronic circuits. BCs perform a similar function, using a battery as an intermediary. The BC first stores energy in the battery, which then powers the consumer product, allowing it to operate without a power cord. The power systems of certain products may include both BCs and EPSs.

DOE is studying technology options that could improve the efficiency of the BCs and EPSs covered in this rulemaking. Accordingly, DOE is reviewing manufacturer catalogs, recent trade publications, technical journals, and patent filings. To gather more information, DOE is conducting manufacturer interviews and consulting with technical experts who have worked on BCs or EPSs.

BC and EPS designs vary according to the maximum output power of the devices, the output voltage, and their intended application. Because the technology options for efficiency improvement will still need to meet the design requirements of a particular BC or EPS, a discussion of designs and product classes precedes a listing of technology options.

3.4.1 Battery Charger Design

Methods of improving BC efficiency depend on whether the BC is a slow charger or a fast charger. The distinction between the two types of BCs is based on the charge rate (also referred to as C-rate), often defined as the average charging current flowing into the battery, divided by the nominal battery charge capacity. For current expressed in amperes and battery capacity expressed in ampere-hours, the resulting quantity is expressed in units of 1/hours or C. For example, a BC with a 0.1 ampere (A) output current charging a 1 ampere-hour (Ah) battery would result in a charge rate of 0.1 C. Charging time is approximately the inverse of the charge rate, adjusted for the efficiency of the battery itself, which varies with chemistry. In the previous example, the battery would take slightly longer than 10 hours to charge.

DOE considers BCs with charge rates less than 0.2 C (typically around 0.1 C) to be slow chargers. At this low charge rate, nickel-based batteries can be charged continuously without concern for excessive battery overheating or safety. Slow chargers do not typically include cutoff or monitoring circuitry. However, as the battery nears full charge and its voltage increases, the difference between the BC output and battery voltages decreases and the charge-control resistance used in a slow charger will cause the charging current to decrease. This reduces power consumption and lessens battery heating due to overcharge (thereby extending battery life). Slow chargers are not typically used in combination with lithium-based batteries, because of the safety concerns associated with overcharging these batteries.

Slow chargers are typically composed of a line-frequency transformer followed by a rectifier and charge-control element. The function of the charge-control element is to limit charging current into the battery, which can be accomplished by either a discrete resistor or the parasitic internal resistance of the transformer windings. The power conversion losses in a slow charger are mostly due to magnetization losses in the transformer core steel, resistive losses in the charge-control element, and voltage drops across the rectifier diodes.

In addition, slow chargers typically continue to deliver current to the battery even after it is fully charged, usually at a rate much higher than that necessary to maintain the charge lost due to battery self-discharge. The excess power is dissipated as heat in the battery. The power conversion losses identified earlier continue to have an impact in this maintenance mode, further increasing power consumption. Even in no-battery mode, when the battery is disconnected from the charger, the slow charger continues to consume significant power due to the transformer magnetization losses. For a detailed discussion of slow-charger power consumption in all modes, please see sections 3.3 and 3.5 of the draft technical report.

A battery charger that contains monitoring, cutoff, or limiting circuitry can safely charge lithium-based batteries and fast-charge nickel-based batteries. DOE considers BCs with charge rates greater than 0.2 C (typically between 0.6 C and 1 C) to be fast chargers. Because the charge rate of fast chargers is much greater than that of slow chargers, the maximum rated output power of a fast charger can be 5 to 20 times greater than that of slow chargers, even when charging a battery of the same voltage and capacity. For this reason, fast chargers typically use switched-mode power supplies (section 3.4.2), which are smaller and lighter than line-frequency power supplies. Fast chargers also employ monitoring and cutoff circuitry, as the high currents used during charging may overheat the battery and lead to a safety hazard if not reduced at the proper time. Because of these design differences, fast chargers are composed of more complex circuits and are susceptible to different loss mechanisms than slow chargers.

The high-frequency switched-mode power supply (whether internal or external) that typically performs the energy conversion in a fast charger is usually more efficient than the line-frequency transformer and rectifier discussed previously. High-frequency power supplies can use transformer cores made of ferrite that are smaller and more efficient than the steel cores typically found in line-frequency designs. However, there are still conversion losses associated with switching and rectification, as well as fixed overhead losses associated with powering the integrated circuit (IC) switching controller and any safety circuitry. Also, although fast chargers terminate (*i.e.*, limit charging current once the battery has reached full charge), most chargers continue to supply a small amount of maintenance current. As with slow chargers, this maintenance current and the associated conversion losses contribute heavily to maintenance-mode power consumption. Finally, even with the battery removed, the charger can continue consuming significant power due to the overhead of powering the control and safety circuitry mentioned above. For a more detailed discussion of fast-charger power consumption, please see sections 3.3 and 3.5 of the draft technical report.

Further, manufacturers may, and often do, choose to substitute a fast charger for a slow one as a means of improving portability and energy efficiency. Because both types of chargers can often be used with the same battery powering the same consumer product, they provide the same utility to the consumer, which sometimes means the fast charger can be considered an option for the baseline slow charger.

Finally, because changes in battery temperature and voltage happen more slowly at lower charge rates, monitoring circuitry that depends on these changes to stop the charging process is typically not sensitive enough to be used at rates below 0.3 C. Therefore, although DOE differentiates between BCs with charge rates greater than or less than 0.2 C, DOE does not expect to find many BCs with charge rates between 0.15 C and 0.3 C.

Item 20 *DOE seeks comments on whether the 0.2 C charge-rate division between slow and fast chargers is appropriate and seeks detailed information regarding the typical charge rates for both categories of BCs.*

3.4.2 External Power Supply Design

To power a consumer product, EPSs must meet numerous specifications; of these, output power and output voltage have the largest impact on EPS efficiency. Together, the output power and voltage determine the current, which has the greatest impact on conduction losses and associated power dissipation in the EPS.[20] EPSs are generally designed to provide power at a fixed output voltage with variable current to a consumer product.

The consumer product powered determines the EPS design criteria, including output power, output voltage, and the tolerance of the output voltage. EPSs designed for consumer products that require precise voltages (*e.g.*, computers) will incorporate output voltage regulation to minimize voltage fluctuations caused by load or power source variations. Other applications that can tolerate some voltage fluctuation may use simpler EPSs, with no regulation of the output voltage.

In these unregulated line-frequency EPSs, the two main sources of loss are the transformer and the rectifying diodes. A transformer consists of two wires wrapped around a metal core. As current passes through the primary wire, power is transferred to the secondary wire (usually at a lower voltage) through magnetic induction in the core.[21] The quality of the metal core, the intensity of magnetic induction, and the gauge of the wires determine transformer losses. The transformer secondary current then passes through rectifier diodes that have voltage drops that also cause losses. Typically, diodes have a drop of 0.6 volts; this fixed voltage drop constitutes a larger share of the losses at lower voltages.

[20] The draft technical report discusses conduction losses in more detail.
[21] Magnetic induction is is the coupling of the magnetic fields surrounding the primary and secondary windings, allowing the transfer of power from one to the other without a galvanic (*i.e.*, conductive) connection between the two.

To achieve voltage regulation, one can add a second stage, such as a linear regulator, to the line-frequency power conversion stage described above, or redesign the power conversion stage entirely, using a switched-mode design or topology. Because the AC/DC conversion stage of a regulated line-frequency EPS is essentially the same as that of an unregulated EPS, it has the same loss mechanisms. The linear voltage regulation stage adds to these losses by passing power from the AC/DC converter to the consumer product through a power-dissipating element. This regulation stage senses the output voltage and adjusts the current flowing through it to keep the output voltage proportional to a fixed reference. Loss in a regulated line-frequency EPS is caused by the conversion stage delivering current at a higher voltage than needed by the consumer product, and dropping the excess voltage across the regulator to achieve the (lower) regulated output voltage. The power lost in the regulator is the product of the voltage drop and the load current and is dissipated as heat.

A switching regulator can also follow the line-frequency AC/DC power-conversion stage, in place of the linear regulator described above. These tend to be much more efficient than linear regulators because they do not dissipate excess power through a linear control element. Rather, they switch the output at high frequency, adjusting the proportion of "on" time during each switching cycle (*i.e.*, the duty ratio) to maintain the regulated output voltage proportional to a fixed reference. Due to their higher costs, these switching regulators are not as common as linear regulators.

The unregulated and two-stage regulated EPSs discussed above are called line-frequency EPSs because the frequency of the current passing through their transformers is the same as that of the AC mains current (nominally 60 Hz in the United States). Switched-mode power supplies (SMPS) convert power differently than line-frequency EPSs. SMPSs first rectify the AC mains current to high-voltage DC, converting it back to AC by switching the current on and off at high frequencies. The high-voltage, high-frequency AC current then passes through the primary winding of a transformer while the output from the secondary winding of the transformer is rectified, resulting in a low-voltage DC output. Because of the high frequency of the AC current passing through the transformer, the transformer can be made smaller, resulting in lower losses, weight, and material costs, all of which decrease with transformer volume.

Although DOE is aware of unregulated switched-mode power supplies used for specific applications, most switched-mode EPSs are regulated. In these EPSs, the output voltage signal is used to control the primary-side switching element, taking power from mains to match the needs of the consumer product load and maintaining a constant output voltage.

The critical elements in a switched-mode EPS are the transistor, output rectifier, transformer, and controller. A transistor acts as a switch that constrains the flow of power into the transformer, through the output rectifier and, ultimately, to the consumer product. A controller, typically an IC, senses the output voltage of the EPS and switches the transistor on and off at frequencies in the kilohertz range. By adjusting the duty ratio, the IC controls both the average current through the primary winding of the transformer and the output voltage of the EPS.

Further, the IC can greatly increase efficiency by reducing power consumption in no-load mode, the condition when the EPS has been disconnected from the load, resulting in zero output current. The IC can also limit power dissipation in active mode by switching the transistor during the lowest portions of its current or voltage wavevorms. As before, the power lost in the transistor is proportional to the product of current and voltage, so performing the transistor state transition when either quantity is zero significantly decreases losses.

After passing through the transformer, the current is rectified and filtered before reaching the consumer product. Principal sources of loss in a switched-mode EPS are the transistor switching transients, transistor magnetization and resistive losses, controller IC power consumption, and rectifier losses. Although the number of different sources of loss is higher in switched-mode EPSs than in line-frequency EPSs, the total power lost in switched-mode EPSs tends to be lower. (See section 3.7.2 for more discussion on the efficiency of switched-mode EPSs.)

3.5 Measuring Efficiency

An evaluation of the effectiveness of technology options for efficiency improvement and the tradeoffs between them depends heavily on the measures used to quantify the efficiency of BCs and EPSs. DOE has already adopted test procedures for measuring the energy consumption of both BCs and EPSs. This section presents a brief discussion of the test procedures and any issues related to the test procedures that may affect the energy conservation standards rulemaking.

Within this document, the term "energy consumption" is used loosely to refer to power dissipation or power consumption of BCs and EPSs in one of their several modes. Likewise, "efficiency" can mean EPS active-mode efficiency or BC energy ratio, both discussed in the following sections. More generally, "efficiency" can also refer to the energy consumption of a BC or EPS against that of comparable devices in any of their modes.

3.5.1 Measuring Battery Charger Efficiency

On December 8, 2006, DOE adopted a test method to measure the efficiency of battery chargers (section 1.2.1). 71 FR 71340. This test method, based on the U.S. Environmental Protection Agency's (EPA) ENERGY STAR "Test Methodology for Determining the Energy Performance of Battery Charging Systems," integrates the power consumed by BCs in maintenance and no-battery modes over fixed periods of time. This "nonactive energy" is divided by the battery energy, measured at a discharge rate of 0.2 C, resulting in an energy ratio. Normalizing by battery energy is meant to account for proportionally higher losses in chargers intended for higher-energy batteries. A higher energy ratio represents higher BC nonactive energy consumption.

However, in the December 8, 2006, Test Procedure Final Rule, DOE stated that it intended to study further BC active mode energy consumption and reserved a section in the test procedure (section 4(b) of appendix Y to subpart B of 10 CFR Part 430) to cover active mode energy consumption. 71 FR 71340, 71360. DOE is currently developing an approach for measuring BC active—*i.e.* charging—mode energy consumption and is considering adopting a test procedure that would return multiple metrics that would correspond to energy consumption in each of the modes of operation of a BC.

Under this approach, these separate metrics would then be weighted during the energy use and end-use load characterization (section 6) to reflect the typical usage of BCs in each product class. The potential energy conservation standards for each class would likewise be written in terms of a single metric even though the test procedure would measure consumption in each of the modes separately. Manufacturers would then be free to trade power consumption in one mode for another as long as they meet the mode-weighted power consumption required by the standard.

Also, in a separate rulemaking, DOE amended the BC test procedure, adding measurement of power consumption during off mode and standby mode for BCs. As presented in the test procedure final rule, standby mode is defined as the condition where the BC is connected to mains, the battery or product with an integral battery is disconnected from the charger, and any on-off switches are turned on. Off mode is defined to be applicable only to BCs with on-off switches, and is the same condition as standby mode, with the caveat that all on-off switches are off. Because both off mode and standby mode are nonactive modes, this standby and off mode final rule did not expand the test procedure to measure energy consumption in active mode. 74 FR 13334.

Item 21 *Although DOE intends to revisit this issue in the future, its test procedure does not currently measure active-mode energy consumption. Nonetheless, DOE seeks comments on how it can best account for energy consumed during active mode.*

Item 22 *DOE seeks comments on how DOE could, in a future rulemaking, amend its BC test procedure to measure energy consumption in active mode.*

3.5.2 Measuring External Power Supply Efficiency

On December 8, 2006, DOE codified a test procedure final rule for EPSs in appendix Z to subpart B of 10 CFR Part 430 ("Uniform Test Method for Measuring the Energy Consumption of External Power Supplies"). 71 FR 71340. DOE's test procedure, based on the ENERGY STAR EPS test procedure, measures active-mode efficiency and no-load-mode (standby-mode) power consumption. In the standby and off mode test procedure NOPR for BCs and EPSs, 73 FR 48054 (August 15, 2008), DOE proposed to amend the EPS test procedure to add a measurement of power consumption in off mode, where, if the EPS has an on-off switch, the EPS is connected only to mains and the switch is turned off. These amendments were included in the final rule, published March 27, 2009. 74 FR 13335.

Active mode conversion efficiency is the ratio of output power to input power. DOE averages the efficiency at four loading conditions—25, 50, 75, and 100 percent of maximum rated output current—to assess the performance of an EPS when powering diverse loads. DOE also measures the power consumption of the EPS when disconnected from the consumer product, which is termed no-load power consumption. DOE combines both of the above metrics into "matched pairs" that describe the CLSs used in setting potential energy conservation standards, discussed further in section 5.1.

3.6 Product Classes

When necessary, DOE divides covered products into classes by the type of energy used, the capacity of the product, and any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) DOE then conducts its analysis and considers establishing or amending standards to provide separate standard levels for each product class. In this section, DOE summarizes the various product classes used by EISA, ENERGY STAR, and the draft analysis prepared by DOE for the determination in 2007. (See section 3.6 of the draft technical report for details on these product classes.)

3.6.1 Battery Charger Product Classes

There are several capacity- and performance-related features of a BC that could be used for classification, including the charging method it uses (continuous charging or terminating charging), the charge rate, the voltage or capacity of the battery or batteries charged, and/or the battery chemistry.

For example, ENERGY STAR uses product classes for battery charging systems based on the voltage of the batteries or battery packs they charge. The ENERGY STAR specification contains 20 product classes, from 1.2 volts to greater than 24 volts, in 1.2 volt increments. ENERGY STAR does not distinguish among battery charging systems by charging method, charge rate, battery capacity, or battery chemistry. There are no State or international standards for BCs.

In conducting the determination analysis mandated by EPACT and superseded by EISA, DOE divided battery chargers into product classes based on battery voltage. This characteristic, more than any other, impacts the performance and utility of the battery charger. Battery voltage has a large impact on attainable battery charger efficiency as well as the opportunities for efficiency improvement. Furthermore, a BC designed for one battery voltage cannot be replaced with one designed for another, as it is the consumer product application that sets the battery voltage.

Although one cannot easily exchange a fast charger for a slow one without significantly affecting consumer utility, the same cannot be said of the converse. In fact, exchanging a slow charger that uses a line-frequency power supply for a fast charger with a switched-mode power supply was a technology option for improving efficiency (section 3.7) that manufacturers identified during interviews held in 2007.

Additionally, class divisions based on battery voltage permitted DOE to analyze the different technological paths to energy-efficiency improvement in the major categories of BCs for consumer products. For example, most chargers for personal-care applications (*e.g.*, shavers, beard trimmers, etc.) have an output voltage less than 3 V, while those for power tools have an output greater than 9 V. Using product class divisions based on voltage would, therefore, allow DOE to account for the varied usage of chargers for diverse consumer product applications by differentially weighting their energy consumption in each mode based on the usage. Table 3.7 shows the product classes used in the determination analysis, while section 3.6.2 of the draft technical report describes them in detail.

Table 3.7. Battery Charger Product Classes Developed for the Draft Determination Analysis

Battery Voltage	Product Class
0 V through 3 V	A
>3 V through 9 V	B
>9 V through 48 V	C

Item 23 *DOE seeks comments on BC product class divisions, including whether battery voltage is the appropriate product classification criterion, and/or whether DOE should take into account other factors, such as charge rate, battery capacity, or battery chemistry.*

3.6.2 External Power Supply Product Classes

Output power and output voltage have the largest impact on achievable EPS efficiency (section 3.5.2); consequently, DOE is considering one or both of these criteria in developing EPS product classes for its preliminary analyses. DOE is reviewing EPS product classes created by EISA, ENERGY STAR, and manufacturers to determine what role output power and voltage play in their definitions. EISA defines Class A EPSs and sets efficiency standards by EPS output power. Version 1.1 of the ENERGY STAR specification only considered EPS output power but Version 2.0 considers output power, input power, conversion type (AC/DC versus AC/AC), and output voltage.

In a previous analysis presented in section 3.6.1 of the draft technical report, DOE developed product classes by output power and output voltage based on manufacturer input. In this section, DOE summarizes these methods for establishing product classes and seeks comments from interested parties in developing product classes for its preliminary analyses.

As mentioned in section 1.1, EISA amended EPCA, establishing energy conservation standards for Class A External Power Supplies that became effective on July 1, 2008. These energy conservation standards divide Class A EPSs into three product classes based on rated nameplate output power (in watts): less than 1 watt, 1–51 watts, inclusive; and greater than 51 watts. Table 3.8 shows the classes and energy conservation standards established by EISA.

Table 3.8. EISA Efficiency Standards for Class A EPSs

Nameplate Output	Active-Mode Required Efficiency (decimal equivalent of a percentage)
<1 watt	0.5 times the nameplate output
1 to 51 watts	The sum of 0.09 times the natural logarithm of the nameplate output and 0.5
>51 watts	0.85

Nameplate Output	Maximum No-Load-Mode Power Consumption
No more than 250 watts	0.5 watts

Section 321 of EPCA, as amended by section 301 of EISA, defines a Class A External Power Supply as a device that (1) is designed to convert line voltage AC input into lower voltage AC or DC output; (2) is able to convert to only one AC or DC output voltage at a time; (3) is sold with, or intended to be used with a separate end-use product that constitutes the primary load; (4) is contained in a separate physical enclosure from the end-use product; (5) is connected to the end-use product through a removable or hardwired male-female electrical connection, cable cord, or other wiring; and (6) has nameplate output power that is less than or equal to 250 watts.

As such, the product classes listed in Table 3.8 do not apply to EPSs with output power greater than 250 watts or with multiple simultaneous output voltages. The statute further excludes any device that: (I) requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c); or (II) powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated." All products that are excluded or not covered under the definition of "Class A External Power Supply" will be evaluated under the determination analysis for non-Class A EPSs required by EPCA, as amended by EISA. See 42 U.S.C. 6295(u)(1)(E).

This topic is discussed further in section 3.2.1. In the context of this section, DOE seeks comment on how to extend the product-class divisions for Class A EPSs, introduced by EISA, to non-Class A EPSs, or how to create novel product-class divisions for non-Class A EPSs.

Item 24 *DOE seeks comments on creating potential product class divisions for EPSs excluded from the EISA definition of Class A.*

The ENERGY STAR program for EPSs, led by EPA, created the first EPS specification in 2004 (Version 1.1), and the product classes set forth by ENERGY STAR have affected other programs since. On April 23, 2008, EPA issued its ENERGY STAR specification Version 2.0 for EPSs, where it presented two product class structures (Table 3.9 and Table 3.10) based on output power and output voltage as well as output current, input power, power factor, and conversion type (AC/AC or AC/DC). [22]

Table 3.9. ENERGY STAR Version 2.0 Active-Mode EPS Product Classes

Model Type	Nameplate Output Power		
	≤1 Watt	1–49 Watts	>49 Watts
Low-Voltage Models*	A	B	C
Standard Models	D	E	F

*Low-voltage models have output voltage of less than 6 volts and an output current greater than or equal to 550 milliamps.

Table 3.10. ENERGY STAR Version 2.0 No-Load-Mode EPS Product Classes

Conversion Type	Nameplate Output Power	
	<50 Watts	≥50 Watts
AC/AC Converters	W	X
AC/DC Converters	Y	Z

These product classes are based on the Version 1.1 product classes, which divide EPSs at a no-load-mode consumption of 10 watts and output power of 1 and 49 watts. Version 2.0 retained these product-class divisions based on feedback from interested parties. Based on additional feedback, ENERGY STAR also created separate product classes for AC/AC converters, low-voltage units, and high-input-power units.[23]

Input from interested parties also prompted ENERGY STAR to create a separate no-load power consumption specification for AC/AC EPSs because those converters are typically limited to line-frequency architectures and cannot meet the same no-load power consumption levels as switched-mode AC/DC EPSs. Additionally, the proposed ENERGY STAR Version 2.0 Program Requirements set a less stringent specification for low-voltage units with an "output voltage less than 6 volts and an output current greater than or equal to 550 milliamps."[24] Interested parties sought a separate product class for low-voltage EPSs because, for the same power, lower output voltages result in higher currents and associated conduction losses. Lower voltage EPSs are further affected by proportionally greater losses due to voltage drops in the output rectifier.

Finally, interested parties prompted ENERGY STAR to include minimum power factor and efficiency requirements for high-power EPSs with input power of 100 watts or greater, where the power factor is the ratio of real power to total power drawn by the EPS. Due to

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[22] "ENERGY STAR® Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies Eligibility Criteria (Version 2.0) Revised Final Draft." April 2008. Available at www.energystar.gov/ia/partners/prod_development/revisions/downloads/Spec.pdf.
[23] "Cover Letter to Accompany Final Draft of EPS Specification Version 2.0." February 19, 2008. Available at www.energystar.gov/ia/partners/prod_development/revisions/downloads/CoverLetterV2.pdf.
[24] "ENERGY STAR Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies Eligibility Criteria (Version 2.0) Revised Final Draft." April 2008. Available at www.energystar.gov/ia/partners/prod_development/revisions/downloads/Spec.pdf.

nonlinear and energy-storage circuit elements such as diodes and inductors, respectively, electrical products often draw currents that are not proportional to the line voltage. These currents are either distorted or out of phase in relation to the line voltage, resulting in no real power drawn by the EPS or transmitted to the load. However, although the EPS itself consumes no real power, these currents are real and cause power dissipation from conduction losses in the transmission and distribution wiring. For a given nameplate output power and efficiency, products with a lower power factor cause greater power dissipation in the wiring, an effect that also becomes more pronounced at higher input powers. Therefore, in light of these concerns, ENERGY STAR, through Version 2.0, limits the power factor of EPSs with an input power of 100 watts or greater, effectively creating an additional product class division based on input power.

Taking into consideration the ENERGY STAR Version 1.1 specification and manufacturer suggestions, DOE developed product classes based on output power for its determination analysis, presented in section 3.6.1 of the draft technical report. DOE divided the EPSs into low-, medium-, and high-power units, with the boundaries at 4 and 60 watts nameplate output power. Based on manufacturer inputs, DOE expected EPSs in each product class to share design characteristics that would affect the cost of increasing active-mode efficiency and decreasing no-load power consumption. For example, DOE did not expect low-power switched-mode EPSs with output power of less than 4 watts to contain a controller IC, due to the high cost of an IC in relation to the total cost of the EPS. Because an IC is necessary for reducing power consumption at light and no load through such strategies as cycle-skipping, the high proportional cost of an IC would lead to an increased cost of improving no-load power consumption for low-power EPSs.

Similarly, DOE expected EPSs with output power greater than 60 watts to exhibit a two-stage circuit architecture with active power factor correction (PFC), which is necessary for meeting power-factor requirements under the European Union Code of Conduct, a voluntary agreement of EPS manufacturers described later in Appendix F Due to the global nature of the EPS market, these requirements would affect the design of and cost-efficiency relationship for high-power EPSs in the United States.

However, after analyzing 32 EPSs with output power less than 6 watts and 18 EPSs with output power greater than 50 watts, DOE was unable to find support for power level product class divisions. There were no clear thresholds at which manufacturers would begin to use controller ICs or PFC circuitry. Therefore, although DOE recognizes the important role of ICs and PFC in EPS design and anticipates further analysis of these criteria, it is not currently considering EPS product classes related to these criteria.

In interviews held in 2007, manufacturers also suggested that DOE differentiate the EPS product classes by output voltage in addition to output power. This is because when comparing EPSs with the same output power, EPSs with lower output voltages have higher conduction and diode-drop losses that pose additional challenges to achieving high efficiency. To address this situation, manufacturers suggested that DOE further subdivide its product classes by output voltage, with a division at 12 volts, which is the point where the approximately 0.6-volt diode drop results in losses equal to 5 percent of the output voltage Table 3.11 presents the product classes that DOE used in its determination analysis and described in detail in section 3.6.1 of the draft technical report.

Table 3.11. Product Classes Used in the EPS Determination Analysis

Nameplate Output Voltage	Nameplate Output Power		
	<4 Watts	**4–60 Watts**	**>60 Watts**
<12 volts	A	B	C
≥12 volts	D	E	F

Item 25 *DOE seeks comments on whether to consider the presence of ICs or PFC circuitry in developing product classes for EPSs.*

Item 26 *DOE seeks comments on how to consider output voltage in developing product classes, and how the low-voltage division should vary with EPS output power.*

Class A EPSs represent the vast majority of EPSs manufactured and sold. This group encompasses a broad range of products with many different designs and end-use utilities and applications. DOE is considering a few possible approaches concerning EPS product classes. Two options include: (1) subdividing the EISA Class A standard product classes, which are based on output power, into even narrower product classes that take into account unit output voltage; or (2) establishing new product classes based on output power divisions different from what the Class A EISA standard uses. Based on comments from interested parties, DOE may use one of these two approaches, modify one approach, or use an entirely different Class A EPS product class structure for the preliminary analyses.

Item 27 *DOE seeks comments on the possible approaches discussed concerning EPS product classes, and invites interested parties to propose alternative approaches and/or other factors DOE should consider in developing product classes for the preliminary analyses.*

As discussed earlier, EPCA, as amended by EISA, also requires DOE to conduct a determination analysis that considers EPSs other than Class A. While conducting the determination analysis, DOE may define additional classes of EPSs, for example, EPSs with nameplate output power greater than 250 watts and EPSs that are able to convert to more than one AC or DC output voltage simultaneously. If the determination is positive, standards for certain additional classes of EPSs may be considered under the scope of this energy conservation standards rulemaking.

Item 28 *DOE seeks comments on how the product classes it is considering for Class A EPSs may apply to non-Class A EPSs and whether there are particular issues DOE needs to take into account.*

Item 29 *DOE seeks comments on all aspects of the product classes it is considering for BCs and EPSs, as well as any other methods for establishing product classes in accordance with the requirements of 42 U.S.C. 6295(q).*

3.7 Technology Options for Efficiency Improvement

3.7.1 Battery Charger Technology Options

The following list, organized by charger type, provides preliminary technology options that DOE intends to evaluate during the preliminary analyses. A detailed discussion of the specific technology options can be found in section 3.8.2 of the draft technical report. Although many of these technology options could be used in both fast and slow chargers, doing so may be impractical due to the cost and benefits of each option for the two types of chargers. Therefore, in the list below, the options are grouped with the charger type where they would be most practical.

Slow charger technology options include:

- *Improved Cores*: The efficiency of line-frequency transformers, which are a component of the power conversion circuitry of many slow chargers, can be improved by replacing their cores with ones made of lower-loss steel.

- *Termination*: Substantially decreasing the charge current to the battery after it has reached full charge, either by using a timer or sensor, can significantly decrease maintenance-mode power consumption. Because most slow chargers have a charge rate of approximately 0.1 C, and maintenance-mode current below 0.05 C is typically sufficient to keep a battery fully charged, a slow charger that employs termination can roughly halve its maintenance-mode power consumption.

- *Elimination/Limitation of Maintenance Current*: Constant maintenance current is not required to keep a battery fully charged. Instead, the BC can provide current pulses to "top off" the battery as needed. Elimination or limitation of maintenance can decrease maintenance-mode power consumption even further and has the added benefit of extending the battery lifetime by reducing heating due to overcharge.

- *Elimination of No-Battery Current*: A mechanical AC line switch inside the battery charger "cup" automatically disconnects the BC from the mains supply when the battery is removed from the charger. Although manual (*i.e.*, user-controlled) switches are also possible, this method guarantees that the BC ceases to consume power once the battery is removed from the battery charger.

- *Switched-Mode Power Supply*: To increase efficiency, line-frequency power supplies can be replaced with switched-mode EPSs, which greatly reduce the biggest sources of loss in a line-frequency EPS: the transformer. Because a switched-mode EPS operates at high frequency (greater than 20 kHz), its transformer can be smaller, and because transformer losses are a function of volume, a smaller transformer is usually more efficient. It is worth noting that this technology option is not often found in practice, because the inclusion of a switched-mode power supply within the BC design allows the higher power levels necessary for fast charging. The universal consumer preference for shorter charging times limits the occurrence of slow chargers with high-frequency switched-mode power supplies.

Fast charger technology options include:

- *Low-Power Integrated Circuits*: The efficiency of the BC's switched-mode power supply can be further improved by substituting low-power IC controllers, which can switch more efficiently in active mode and reduce power consumption in no-load mode. To increase efficiency in active mode, the IC controller can decrease switching transients through zero-voltage or zero-current switching. Furthermore, the IC can turn off its start-up current (sourced from the primary side of the power supply) once the output voltage is stable. In addition, when in no-load mode, the IC can turn off the switching transistor for extended periods of time (termed "cycle-skipping").

- *Elimination/Limitation of Maintenance Current*: See above.

- *Schottky Diodes and Synchronous Rectification*: Both line-frequency and switched-mode EPSs use diodes to rectify output voltage. Schottky diodes and synchronous rectification can replace standard diodes to reduce rectification losses, which are increasingly significant at low voltage. Schottky diodes are rectifiers constructed from a metal-silicon junction rather than a *p-n* silicon junction and have a voltage drop of 0.3–0.4 volts, compared to approximately 0.6 volts for standard *p-n* junction diodes. Synchronous rectification (which is typically used only in switched-mode EPSs) further reduces losses by substituting field-effect transistors (FETs) for the diodes. The voltage drop across the drain-to-source resistance of the FET is much lower than that of a Schottky diode, leading to lower losses in the output rectifier.

- *Elimination of No-Battery Current*: See above.

- *Phase Control to Limit Input Power*: Even when a typical BC is not delivering its maximum output current to the battery, its power conversion circuitry continues to draw significant power. A phase control circuit, like the one present in most common light dimmers, can be added to the primary side of the BC power supply circuitry to limit input current in lower-power modes.

3.7.2 External Power Supply Technology Options

The technology options under consideration that may improve the efficiency of EPSs, as discussed in section 3.4.2, are listed below. Because many of the technology options are the same as those for BCs, please refer to the discussion in section 3.7.1 for additional details.

- *Switched-Mode Power Supply*: Unlike battery chargers (see above), line-frequency EPSs often use linear regulators to maintain a constant output voltage. By using a switched-mode circuit architecture, a designer can limit both losses associated with the transformer and the regulator.

- *Low-Power Integrated Circuits*: See Battery Charger Technology discussion above.

- *Schottky Diodes and Synchronous Rectification*: See Battery Charger Technology discussion above.

- *Low-Loss Transistors*: The switching transistor dissipates energy due to its drain-to-source resistance (R_{DS_ON}) when the current flows through the transistor to the transformer. Using transistors with low R_{DS_ON} can reduce this loss.

- *Resonant ("Lossless") Snubbers*: In switched-mode EPSs, a common snubber protects the switching transistor from the high voltage spike that occurs after the transistor turns off by dissipating that power as heat. A resonant or lossless snubber recycles that energy rather than dissipating it.

Item 30 *DOE seeks comments on the preliminary technology options identified in this section and whether there are other technology options it should consider. In commenting on design options, please discuss their impacts, if any, on safety, performance, and consumer utility.*

4 SCREENING ANALYSIS

The purpose of the screening analysis is to screen out technology options that DOE will not consider in the rulemaking for BCs and EPSs. DOE uses the following process to perform this screening.

DOE starts by developing a list of technology options, developed through its own research and in consultation with interested parties, for consideration in the engineering analysis (section 5). The identified candidate technology options or best available technologies will encompass all those technologies that may be technologically feasible. DOE then reviews each technology option or best available technology in light of the following four criteria, as provided in sections 4(a)(4) and 5(b) of the Process Rule.[25] These criteria have been tailored to the current rulemaking:

(1) *Technological feasibility*: DOE will not consider technologies that are not incorporated in commercially available products or working prototypes.

(2) *Practicability to manufacture, install, and service*: If DOE determines that mass production of a technology in commercial products and reliable installation and servicing of that technology could not be achieved on the scale necessary to serve the relevant market by the time of the effective date of the standard, it will not consider that technology further.

(3) *Adverse impacts on product or equipment utility or availability*: If DOE determines that a technology has a significant adverse impact on the utility of the product to significant subgroups of consumers, or results in the unavailability of any covered product type with performance characteristics (including reliability), features, size, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not consider that technology further.

(4) *Adverse impacts on health or safety*: If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider that technology further.

DOE will document its reasons for eliminating any technology option during the screening analysis, and will provide this documentation for review and comment by interested parties as part of the preliminary TSD. DOE will call those technology options that are not screened out by the above four criteria "design options" and will consider these options in the development of cost-efficiency curves in the engineering analysis.

Item 31 *DOE seeks comments on how the four screening criteria might apply to the technology options discussed in section 3.7, as well as any additional technology option(s) that an interested party recommends to DOE.*

As previously discussed, DOE is considering replacing line-frequency EPSs with switched-mode EPSs as a technology option. However, DOE acknowledges that the two technologies may not have equivalent utility for certain applications. Although switched-mode EPSs attempt to filter the electrical noise from their high-frequency switching, some high-frequency currents may still be present on their input or output lines, where they may interfere with nearby electronic equipment, including the load connected to the EPS. DOE has learned that certain medical, radio, and media player applications could suffer from electromagnetic interference when supplied by a switched-mode EPS instead of a line-frequency EPS. Because

[25] 10 CFR Part 430, Subpart C, Appendix A.

switched-mode EPSs typically include more protections against short circuit and overcurrent conditions, some manufacturers have also reported difficulties when using a switched-mode EPS in place of a line-frequency EPS in high-current applications.

Item 32 *DOE seeks comments on any consumer product applications which require use of a line-frequency EPS, and which could not accommodate use of a switched-mode EPS.*

5 ENGINEERING ANALYSIS

After conducting the screening analysis described above, DOE will perform an engineering analysis based on the remaining design options for efficiency improvement. The engineering analysis consists of estimating the energy consumption and cost of products at various levels of increased efficiency. Section 5.1 provides an overview of the engineering analysis. Section 5.2 discusses the representative units selected for BCs and EPSs. Section 5.3 describes DOE's proposed approach to the engineering analysis for both products. Section 5.4 addresses proprietary designs, and section 5.5 discusses cumulative regulatory burdens that might affect the engineering analysis.

5.1 Engineering Analysis Overview

The purpose of the engineering analysis is to determine the relationship between BC and EPS efficiency and manufacturer selling price.[26] This relationship serves as the basis for the underlying costs and benefits to individual consumers (section 8, LCC analysis) and the Nation (section 10, national impact analysis (NIA)). The output of the engineering analysis provides the manufacturer selling price at selected, discrete candidate standard levels (CSLs) of efficiency. CSLs are generally based on (1) design options associated with the specific units being analyzed; (2) other voluntary specifications or mandatory standards that cause manufacturers to develop products at particular efficiency levels; and (3) the maximum technologically feasible level.[27] For example, DOE often considers the ENERGY STAR level as one CSL.

DOE begins the engineering analysis by identifying the representative product classes and selecting one representative unit for analysis from each of the representative product classes. DOE presumes that findings relating to the representative unit are applicable to all the units in its product class. Later, the NIA scales the analytical findings for each representative unit to other units in the same representative product class, and from the representative product class to other product classes that DOE did not explicitly analyze.

The analysis of the representative unit begins with the baseline CSL, which models the most common, least-efficient devices in a product class. Once DOE selects the representative units and establishes baseline CSLs, it may choose one or more possible approaches to arrive at a

[26] This price, which is what manufacturers charge distributors and retailers, forms the basis for the price consumers eventually pay.
[27] The "max tech" represents the most efficient design that is commercialized or has been demonstrated in a prototype with materials or technologies available today. "Max tech" is not constrained by economic justification, and typically is the most expensive design option considered in the engineering analysis.

manufacturer selling price for re-designed devices that match the performance characteristics of the representative unit at the baseline CSL, but which have a higher efficiency. DOE has used the following four approaches in prior rulemakings:

(1) *Examination of published prices and efficiency results*: For certain products, prices can be obtained from manufacturer or distributor catalogs. For prices obtained from catalogs, DOE would apply appropriate discounting to account for distributor markup, and catalog prices are typically provided at volumes several orders of magnitude lower than those used in typical production. Using these data, DOE will estimate the manufacturer selling price. Similarly, the results of efficiency tests can often be obtained from manufacturer or distributor literature or from the test databases of other regulatory agencies. This approach examines only commercially available products and may not provide information about the most efficient designs.

(2) *Testing and teardowns*: DOE can purchase commercially available products and conduct its own efficiency tests followed by teardowns (*i.e.*, disassembly of the product to obtain a bill of materials (BOM) and valuation of components). In this approach, sometimes called "reverse engineering," DOE estimates the manufacturer selling price from the resulting BOM and estimated manufacturer markups. DOE examines only commercially available products; therefore, this approach may not provide information about the most efficient designs.

(3) *Efficiency level approach*: DOE interviews product manufacturers, requesting estimates of the manufacturer selling price for commercially available as well as theoretical units at several CSLs. When providing these data, usually under a non-disclosure agreement, manufacturers characterize their least-cost-path to efficiency at each CSL for which DOE requests data. Manufacturers also generally provide some information on the design options used.

(4) *Design option modeling*: In this approach to the engineering analysis, DOE develops or subcontracts product design software that simulates the efficiency of incorporating various combinations of design options into the representative unit. In this approach, the manufacturer selling price at a particular CSL is based on the component costs (*i.e.*, BOM) of the design options necessary to achieve it. DOE obtains component costs from public and private sources and confirms the information during the manufacturer interviews.

Although DOE may use information about design options to help select a particular CSL, the CSLs themselves are not technologically prescriptive and manufacturers are free to use any combination of design options to achieve the efficiency of a given CSL.

Another important consideration in developing CSLs for EPSs is the use of "matched pairs" of active-mode efficiency and no-load-mode power consumption. CSLs based on matched pairs consist of simultaneous requirements of minimum active-mode efficiency and maximum no-load power consumption, instead of a single requirement based on some integrated efficiency metric. Matched pairs allow DOE to base CSLs on existing EPS specifications or standards, such as those developed by ENERGY STAR. As these CSL "matched pairs" progress from least to most efficient, either one or both metrics (*i.e.*, active-mode efficiency and no-load mode power consumption) increase in stringency. By preventing a decrease in the stringency of these metrics, DOE makes a tacit assumption that there is no trade-off between EPS performance in the two modes, and increasing the energy savings in one mode does not necessarily cause a decrease in energy savings in the other.

> ***Item 33*** *DOE seeks recommendations on possible candidate standard levels to use when analyzing EPSs and BCs.*

5.2 Representative Product Classes and Units

Once DOE establishes its product classes for BCs and EPSs, it needs to determine which to study in the engineering analysis, *i.e.*, whether to analyze all the product classes, or select a few representative product classes to study and then scale the findings from those product classes to the remainder. Representative product classes are typically chosen to encompass those types of devices that have the highest market share or some performance characteristic that deserves special consideration.

Within each of the representative product classes, DOE then selects a representative unit, which is the theoretical BC or EPS that DOE will study in the engineering analysis. The representative unit is a theoretical unit specified by characteristics such as battery voltage, charge rate and battery capacity for BCs, or output power and output voltage(s) for EPSs, among others. These characteristics determine the usability of the BC or EPS with a particular end-use product application. As long as they are constant between two BCs or EPSs, these power converters are assumed to be interchangeable, providing consumers with the same utility. Characteristics such as costs and efficiency are variable, allowing DOE to calculate the relationship between improvements in efficiency and material costs, while maintaining constant utility. In other words, these units serve as reference points against which DOE can measure changes resulting from potential energy conservation standards.

DOE develops a separate engineering analysis for each representative unit. Selection of the representative unit is a critical aspect of DOE's analytical process, because this unit is meant to represent the characteristics of common or typical products sold in a given product class. Following selection, DOE evaluates the cost of the representative unit at a baseline efficiency level and any changes in cost necessary for the unit to meet the higher CSLs. The baseline representative unit is often selected to just meet the current energy conservation standard, as is the case for Class A EPSs. However, there are no standards in place for BCs. Therefore, DOE will select representative units typical of the most common or least efficient products offered for sale in the market as the baseline for its analysis.

Once DOE has completed its engineering and subsequent life-cycle cost analyses on the representative units, the results will be scaled from the representative units to the representative product classes, and from those product classes to other product classes DOE did not analyze.

> ***Item 34*** *DOE invites comments on the identification and selection of representative product classes and on models that may serve as good representative units within each product class. DOE also seeks comments on appropriate scaling relationships among product classes for both BCs and EPSs.*

5.2.1 Battery Charger Representative Units

DOE decided to analyze all three BC product classes presented in Table 3.7, as part of its determination analysis presented in the draft technical report. Each class was represented by a unit that served as the focus of the analysis, except for product class C, which was represented by two units, one a slow charger and the other a fast charger. Although most low-voltage battery-operated applications (product classes A and B) used slow chargers, this was not the case with many high-voltage applications, such as professional power tools, which typically ship with fast chargers.

The characteristics of the representative units can be seen in Table 5.1. DOE chose these units because they represent high-volume BCs within each of the product classes discussed in section 3.4.1. Following the engineering analysis, each of the representative units underwent life-cycle cost and payback period analyses. DOE applied the cost-efficiency curves developed for each unit to all the products in its product class during the calculation of national energy savings and national net present value.

Table 5.1. Representative Unit Characteristics for Battery Chargers

Product Class	Battery Voltage	Battery Capacity	Charge Rate	Typical Application
A	1.2 V	1.2 Ah	0.1 C	Shaver
B	4.8 V	1.2 Ah	0.1 C	Vacuum
C	18 V	1.5 Ah	0.15 C	DIY tool
C	18 V	2.4 Ah	1 C	Pro tool

5.2.2 External Power Supply Representative Units

Following further discussion with manufacturers, DOE narrowed its focus within the list of the six product classes it had developed for the determination analysis to three representative product classes. While the original six product classes, presented in Table 3.11, were based on output power and voltage, the three representative product classes, presented in Table 5.2, were based solely on output power. DOE chose these representative product classes and criteria for division because manufacturers design "families" of EPSs with the same output power, but different output voltages. Therefore, for a given output power, low-voltage and high-voltage EPSs share the same design, often differing only in the choice of component values. Because of this similarity of design, there is a functional relationship between the efficiency achievable by units of different output voltage. Therefore, no differential analysis of separate voltage-based representative product classes is necessary.

For each of the three representative EPS product classes analyzed in 2007 (section 3.6), DOE identified a representative unit for evaluation in the engineering analysis. These three units were chosen to represent EPSs that ship with high-volume applications, such as laptop computers and cellular telephones. For additional discussion, please see section 5.2.3 of the draft technical report.

Table 5.2. Representative Unit Characteristics Used for External Power Supplies

Product Class	Output Power (W)	Output Voltage (V)	Typical Application
A	2.75 W	5 V	Cellular Telephone
B	18 W	12 V	Modem
F	90 W	19 V	Laptop Computer

DOE chose the representative unit for Product Class A to represent a typical charger for a cellular telephone, the consumer product associated with the highest volume of EPS sales. DOE chose Product Class B's representative unit to be characteristic of mid-power applications such as a modem or wireless router. Finally, DOE chose the representative unit for Product Class F to represent a high-power application such as a laptop computer or video game console.

DOE invites interested parties to comment on these three representative units and on whether DOE should analyze these or other representative units during the preliminary analyses. Note that DOE is publishing some of the results from the tear-down analysis conducted in 2007 in section 5.5.5 of the draft technical report published in conjunction with this framework document.

Item 35 *DOE seeks comments on representative product classes and selection of representative units from those representative product classes.*

Item 36 *DOE seeks comments on the scaling of findings from representative product classes to other product classes that DOE may not explicitly analyze.*

5.3 Engineering Analysis Approach

This section discusses the Approach DOE intends to follow to estimate the manufacturer selling price for each representative unit (section 5.2) at successively more stringent CSLs.

DOE is considering using three of the four approaches described in section 5.1 to gather data on and validate the relationship between manufacturer selling price and efficiency: (1) an efficiency level approach, (2) testing and teardowns, and (3) examination of published prices and efficiency results. DOE intends to use the manufacturer interviews as one of its data sources, structuring the collection of these data around an interview guide similar to the one presented in appendices 5.A and 5.B of the draft technical report. DOE will perform its own testing and teardowns. DOE will also consult publicly available data to validate the information manufacturers provide.

Item 37 *DOE invites manufacturers to work with DOE in the interviews to help develop aggregated curves of manufacturer selling price versus efficiency for the various representative units.*

In interviews, manufacturers may provide data for products similar to the representative units, rather than the precise representative units. In those cases, DOE will scale the data to be consistent with the representative unit. For example, during the interviews conducted in 2007, manufacturers provided data on EPSs that were similar to the representative units in terms of capacity, functionality, and design, but had slightly different output power or output voltage. DOE then used typical relationships between power and efficiency or voltage and efficiency to adjust the efficiency data so that it would pertain to the representative unit.

For example, EPSs with higher output power tend to be more efficient, so the efficiency of a lower-power unit would be increased when the data were scaled to a higher-power representative unit. This normalization maintained the unit's relative standing within the market in terms of cost and efficiency and accounted for any differences in output power, output voltage, volume, and other characteristics and permitted aggregation of cost-efficiency data from the maximum number of manufacturers. The normalization method is presented in sections 5.4.5, 5.4.9, 5.4.10, and 5.4.11 of the draft technical report.

Item 38 *DOE seeks comments on methods for normalizing cost and efficiency data provided by manufacturers for EPSs with output power and output voltage that differ from those of the representative units.*

Item 39 *DOE seeks comments on the shipment volumes to use for the representative units.*

To validate the manufacturer-provided engineering data, DOE plans to develop a range of possible costs of production, from the bottom up, applying markups to arrive at a manufacturer selling price. The process of evaluating the cost of a BC or EPS starts with DOE conducting tear-downs of commercially available BCs and EPSs, counting parts, and preparing BOMs. Typically, DOE first obtains low-volume BOM costs by summing individual component prices, obtained from electronic distributor catalogs using the largest possible retail volume, typically 500 to 1,000 pieces.

Because manufacturer selling prices calculated from 1000-piece parts costs are too high to meaningfully represent manufacturers' production costs, in the 2007 determination analysis, DOE scaled these low-volume parts costs to reflect what the components would cost in more typical (much larger) volumes. In developing this more typical volume, DOE used a high-volume quote obtained from a distributor to perform the scaling, a process that consisted of calculating scaling ratios of low- and high-volume parts costs for several types of parts, and applying them to all parts of that type in each low-volume BOM. The high-volume parts costs were quoted at a volume of 500,000 pieces, which DOE considers to be a typical yearly volume of a single EPS design for a mid-size manufacturer.

After deciding on an appropriate volume, DOE then applied manufacturer markups to the resultant high-volume BOM cost to account for additional manufacturer costs not included in the BOM. These markups included (1) a production markup, (2) an add-on for packaging and mechanical components, and (3) a non-production markup. The production markup included all direct and indirect labor, indirect materials, local taxes, and factory operating expenses. In addition to the electronics, BCs or EPSs also consist of a plastic enclosure, cords, and other mechanical components such as heat sinks or printed circuit boards. DOE expected the mechanical costs to remain constant at all CSLs and added these costs to the marked-up BOM, rather than applying a second markup. At this point, DOE applied an additional non-production markup to take into account shipping, handling, import duty, and corporate overheads. The result of this markup chain was the manufacturer selling price, which could serve as an input for further analyses. The exact markups DOE used in its determination analysis are described in depth in sections 5.4.6 and 5.4.12 of the draft technical report for BCs and EPSs, respectively.

Even given small manufacturer markups, DOE recognizes that the manufacturer selling prices obtained using the above method are at best an upper bound on the true cost of production. Actual EPS prices are lower because EPS manufacturers typically bypass the distributor used to obtain the high-volume quote. They also often deal at higher volumes. In its preliminary analyses, DOE plans to incorporate additional data on high-volume parts costs, obtained directly from component manufacturers or electronics-industry analysts. DOE welcomes input on factory-direct parts costs at 500,000 pieces per year and 2,000,000 pieces per year, which DOE considers to be typical yearly volumes for single EPS and BC designs. Obtaining parts costs at two different volumes allows DOE to obtain a more accurate cost estimate at additional volumes through interpolation.

Item 40 *DOE seeks comments on this and other possible methods of determining and validating manufacturing costs. DOE is particularly interested in obtaining high-volume component costs and typical manufacturer markups applied to the bill-of-materials cost.*

Finally, DOE realizes that by testing and pricing commercially available EPSs and BCs according to the method described above, it will be able to validate manufacturer-supplied data only along the efficiency range from baseline to best-in-market. DOE cannot purchase and test devices to validate manufacturer estimates at the max-tech CSL, because by definition no products exist in the market beyond the best-in-market CSL. DOE is, however, exploring methods of simulating the performance and evaluating the cost of EPSs and BCs that can meet CSLs beyond best-in-market.

Item 41 *DOE welcomes comment on methods for simulating the performance of highly-efficient EPSs and BCs as a means of validating data provided by manufacturers.*

5.4 Proprietary Designs

DOE will consider in its engineering and economic analyses all design options that are commercially available or present in a working prototype, including proprietary designs, that meet the screening criteria discussed in section 4. However, DOE will consider a proprietary design in the subsequent analyses only if it does not represent a unique path to a given efficiency level. If the proprietary design is the only approach available to achieve a given efficiency level, DOE will reject the efficiency level from further analysis, because the analytical results would appear to favor one manufacturer over others. If, on the other hand, a given energy-efficiency level can be achieved by a number of design approaches, including a proprietary design, DOE may examine the given efficiency level based on that design. DOE is sensitive to manufacturer concerns about proprietary designs and will take appropriate steps to maintain the confidentiality of any proprietary data manufacturers provide. These data will provide input to the competitive impacts assessment and other economic analyses.

Item 42 *Are there proprietary designs of which DOE should be aware for any of the BCs and EPSs under consideration in this rulemaking? If so, how should DOE acquire the cost data necessary for evaluating these designs?*

5.5 Outside Regulatory Changes Affecting the Engineering Analysis

In conducting an engineering analysis, DOE considers the effects of regulatory burdens outside DOE's statutory energy conservation standards rulemaking process that can affect the manufacturers of the covered equipment. Outside regulatory requirements can also affect the energy efficiency or energy consumption of the BCs and EPSs covered under this rulemaking. DOE will attempt to identify all such outside regulatory requirements that could affect the engineering analysis. The consideration of these requirements is closely related to the cumulative regulatory burden assessment that DOE will carry out as part of the manufacturer impact analysis. DOE will consider the comments received on the engineering analysis described in the preliminary TSD and make any necessary changes. The updated analysis will be presented in the NOPR TSD.

Item 43 *DOE seeks comments on regulatory burdens or changes that should be considered in the engineering analysis of BCs and EPSs.*

Item 44 *DOE seeks comments on any other issues that could affect the engineering analysis.*

6 ENERGY USE AND END-USE LOAD CHARACTERIZATION

The purpose of the energy-use and end-use load characterization is to identify how consumers use products and equipment, and thereby determine the energy-savings potential of energy-efficiency improvements. For BCs and EPSs, DOE's analysis will focus on how end users operate BCs and EPSs with the consumer products they power.

The energy-use and end-use load characterization, which is an input to the LCC and national impact analyses, will represent the typical energy consumption in the field. End-use load characterization for BCs and EPSs is comprised of usage profiles, which estimate the time a device spends in each mode in one year. Because of the nature of BCs and EPSs, the usage profile of the device will be related to the usage profile of the associated application. It is difficult to predict changes in usage, so DOE also assumes that usage profiles will not change over the analysis period.

Sections 6.2.1 and 6.3.1 of the draft technical report provide a detailed list of usage profiles for BC and EPS applications.

> ***Item 45*** *DOE seeks comments on the consumer usage profiles presented in sections 6.2.1 and 6.3.1 of the draft technical report. DOE seeks alternate sources, databases, or methodologies for developing usage profiles. DOE also seeks comments on its assumption that the usage profiles do not vary over the analysis period.*

For most electrical appliances, energy consumption is determined by measuring the energy an application draws from mains while performing its intended function(s). However, BCs and EPSs are power conversion devices, and their intended function is to deliver a portion of the energy drawn from mains into another application. Therefore, the traditional method of calculating energy consumption is not appropriate for measuring BC or EPS energy consumption rates, which are more accurately described using the amount of energy dissipated by these devices.

6.1 Battery Charger Energy Use

For the purposes of calculating energy consumption, DOE considers a BC to always be in one of the following four states:

- *Active Mode*: The existing DOE test procedure for BCs defines active mode as the condition in which the battery charger is connected to mains power; a battery is attached to the charger; and the battery is receiving the main charge, equalizing cells,[28] and performing other one-time or limited-time functions necessary for bringing the battery to the fully charged state. (See appendix C);

- *Maintenance Mode*: The existing DOE test procedure for BCs defines maintenance mode as the condition in which the battery charger is connected to mains power and the battery is fully charged, but is still connected to the charger. (See appendix C);

- *Standby Mode or No-Battery Mode*: The existing DOE test procedure for BCs defines no-battery mode as the condition in which the battery charger is connected to mains power and no battery is attached to the charger. As EISA requires, DOE is revising its BC test procedure to address standby mode. In a separate rulemaking, DOE defined standby mode as equivalent to no-battery mode for BCs. (See 74 FR 13318); and

[28] Equalization is a strategy implemented by some chargers whereby the states of charge of all the cells in a battery are brought to the same level to prevent the voltage across any cells from inverting—and thereby damaging the cell—during deep discharge.

- *Unplugged Mode*: Unplugged mode represents the state in which the battery charger is disconnected from mains power. No energy is consumed in this mode.

Unit energy consumption represents the annual consumption of a BC attaining a particular CSL. DOE calculates unit energy consumption at each CSL for each representative unit by combining the usage profile with the energy consumption characteristics for each energy-consuming mode. For BCs, unit energy consumption is the sum of:

(1) *Charge Energy Consumption*: The product of the number of 24-hour charge cycles per year and the 24-hour charge cycle energy consumption;

(2) *Maintenance Mode Energy Consumption*: The product of the time spent in maintenance mode and the power drawn during maintenance mode; and

(3) *Standby Mode Energy Consumption*: The product of the time spent in standby mode and the power drawn during standby mode.

Based on comments from interested parties about the variability of charge time among different battery chargers and charging behavior among end-users, DOE is considering using 24-hour cycles to uniformly account for energy consumption during battery-charging sessions. A 24-hour cycle models the behavior of a user who allows 24 hours for a battery to recharge. The cycle encompasses time spent in active mode, and once the battery reaches full charge, any remaining time spent in maintenance mode. The users of certain products, such as handheld vacuums, may keep the battery connected to the charger for extended periods of time following a 24-hour charge cycle. In these cases, the usage profile would account for additional time spent in maintenance mode, in addition to the time spent in maintenance mode as part of the 24-hour charge cycle.

Item 46 *DOE requests comments on the use of 24-hour charge cycles for estimating energy consumption for BCs in active mode.*

Figure 6.1 shows an example of an estimated usage profile for do-it-yourself (DIY) power tools that DOE created for its determination analysis. A manufacturer trade organization suggested this usage pattern as being typical for this product application. As the figure shows, over the course of a week, a DIY power tool will go through approximately three 24-hour charge cycles, for a total of 72 hours. Time in maintenance mode is also 72 hours, and DOE estimates that the DIY power tool will spend 24 hours in standby mode per week and no time in unplugged mode. This weekly usage profile was then extended over a year to give an annual usage profile. DOE seeks comments on the usage profiles of BC applications. To view the annual usage profiles of all BC applications DOE has analyzed to date, please see section 6.2 of the draft technical report.

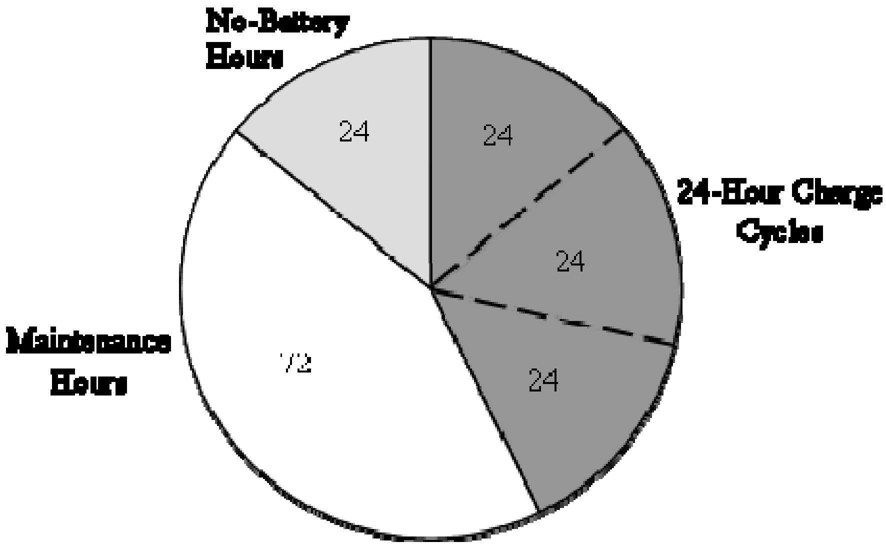

Figure 6.1. DIY Power Tool Weekly Usage Profile in Hours

> ***Item 47*** *DOE requests comments on the methodology presented for calculating unit energy consumption. DOE also requests comments on the usage profiles detailed in section 6.2 of the draft technical report.*

6.2 External Power Supply Energy Use

Unit energy consumption represents the annual consumption of an EPS attaining a particular CSL. DOE calculates unit energy consumption at each CSL by combining usage profiles, which describe the time a device spends in each mode in one year, and the energy consumed by the EPS in each mode of operation.

6.2.1 EPS Usage Profiles

For many applications, usage depends strongly on the individual user. To account for the variety of users and their associated usage profiles, DOE will develop multiple usage profiles where appropriate. DOE will then calculate a weighted-average usage profile based on an estimated distribution of user types.

6.2.1.1 EPS Modes and Application States

Normally, when evaluating usage and energy consumption for a device, it is sufficient to observe only the energy-consuming modes of that device. Because the function of EPSs is to power consumer product applications, however, evaluating the usage and energy consumption of the EPS also requires evaluating the usage and energy consumption of the application itself.

To avoid confusion, when describing usage and energy consumption from the perspective of the application, DOE uses the term “application state.” In contrast, when describing usage and energy consumption from the perspective of the EPS, DOE uses the term “EPS mode.”

By definition all energy-consuming application states are part of active mode from the perspective of the EPS. That is, since any energy-consuming application state requires the application to be connected to the EPS, any energy-consuming application state is part of EPS active mode. These states vary by the type of application.

An EPS can be in active mode, no-load mode, off mode, or unplugged. Table 6.1.gives a summary of these modes.

Table 6.1.Summary of EPS Modes

EPS Mode	Status of EPS Connection to Mains	Status of EPS Connection to Application	EPS On/Off Switch Selection (If Switch is Present)
Active	Connected	Connected	On
No Load	Connected	Disconnected	On
Off	Connected	Disconnected	Off
Unplugged	Disconnected	—	—

- *Active Mode*: EISA generally defines active mode as “the condition in which an energy-using product (I) is connected to a main power source; (II) has been activated; and (III) provides 1 or more main functions.” EISA further defines active mode for EPSs as “the mode of operation when an external power supply is connected to the main electricity supply and the output is connected to a load.”(42 U.S.C.6291(36)(B))

- *Standby Mode or No-Load Mode*: EISA describes no-load mode for EPSs as “the mode of operation when an external power supply is connected to the main electricity supply and the output is not connected to a load.”(42 U.S.C. 6291(36)(D)) Accordingly, DOE revised its EPS test procedure to address standby mode. In a separate rulemaking proceeding published in the *Federal Register* on March 27, 2009, (74 FR 13318), DOE defined standby mode as equivalent to no-load mode for EPSs.

- *Off Mode:* Off mode is a mode applicable only to an EPS with an on/off switch in which the EPS is connected to mains, is disconnected from the load, and the on/off switch is set to “off.” Off Mode is discussed further in section 6.3.

- *Unplugged Mode*: Unplugged mode is the state when the EPS is disconnected from mains power. No energy is consumed in this state.

Consider a usage profile for an inkjet computer printer. DOE identified the following application states for multifunction devices. In each of these application states the EPS is in active mode:

- *Printing:* Where the inkjet printer is on and performing one of its primary functions.

- *Idle:* Where the printer is on but not performing any printing tasks.

- *Off:* Where the printer is off (whether by automatic shutdown or by a user-controlled on/off switch).

As illustrated in Table 6.2, in each application state, the power demands of the inkjet printer differ, so the EPS must supply a different amount of power for each state the application is in.

Table 6.2. Usage and Output Power of 40W EPS for Inkjet Computer Printer

EPS Mode	Application State	Annual Usage (hours/year)	Reasoning	EPS Output Power (W)
Active	Printing	52	Device in operation for 1 hour per week, or roughly 10-15 minutes a day (5-7 tasks) each day of a 5-day work week.	32*
	Idle	1,606	Device left idle for ~30 hours per work week, or 6 hours per day for 5 days a week.	9.1
	Off	7,102	Device turned off when not in use.	6.2
No Load	Disconnected from EPS	0	The EPS is never disconnected from the load but left connected to mains.	0
Unplugged	Disconnected from EPS	0	EPS is never disconnected from mains.	0
* DOE estimated EPS output power for printing to be 80 percent of nameplate output power. Usage profile derived from TIAX LLC, "U.S. Residential Information Technology Energy Consumption in 2005 and 2010." Prepared for U.S. Department of Energy March 2006.				

Item 48 *DOE requests comments on the usage profiles for EPS applications detailed in section 6.3 of the draft technical report.*

6.2.2 EPS Power Consumption by Modes of Operation

EPS power consumption is a function of three factors: the nameplate output power of the EPS, the efficiency of the EPS, and the consumption of the EPS when in no load mode.

No-load mode power (P_{NL}) is the measured power drawn by the EPS from mains while in no-load mode. Because the EPS is disconnected from the application, all of the power drawn from mains is consumed by the EPS. For each candidate standard level, an associated no-load mode power is given.

EPS power consumption during active mode varies as the power requirements of its load vary. Nameplate output power is the highest output power that an EPS is capable of delivering.

DOE intends to use two different approaches to calculating EPS power consumption in active mode—one for application states requiring 25 percent or more of the EPS's nameplate output power and another for application states requiring less than 25 percent.

The approach for application states requiring 25 percent or more of the EPS's nameplate output power is straightforward. The EPS test procedure measures the active mode efficiency (η) of the EPS at 25, 50, 75, and 100 percent of nameplate output power or current. The active mode efficiency of the EPS is then defined as the average of these 4 values (points 2, 3, 4, and 5 in Figure 6.2.) As such, power consumption is

$$P_{Con} = P_{In} - P_{Out}$$

where

$$P_{Out} = P_{In} \text{ x } \eta$$

or

$$P_{In} = P_{Ou}t \text{ x } (1/\eta)$$

Therefore,

$$P_{Con} = P_{Out} \text{ x } (1/\eta - 1)$$

For example, an EPS delivering an output power of 10 watts at 75 percent efficiency would consume:

$$P_{Con} = 10 \text{ W x } (1/0.75 - 1) = 3.33 \text{ W}$$

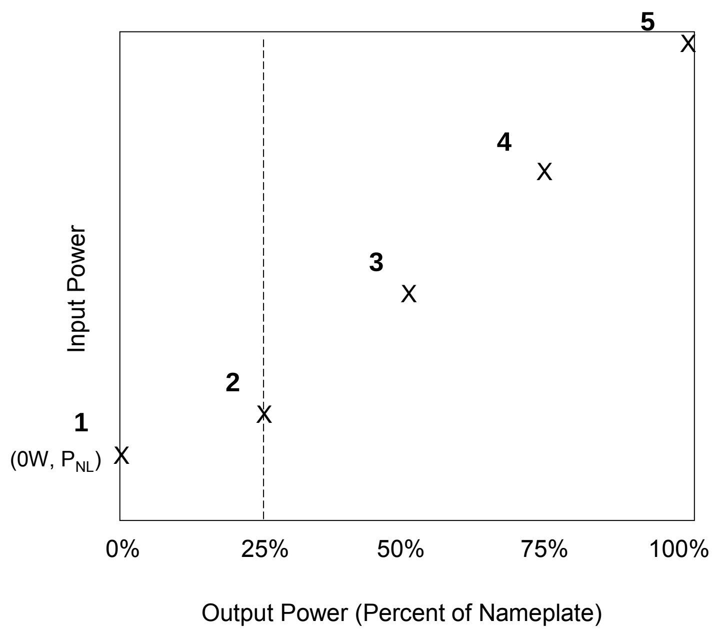

Figure 6.2. Example Measurements from an EPS Test Procedure

The approach for application states requiring less than 25 percent of the EPS's nameplate output power blends measures of the EPS's active-mode efficiency and no-load mode power consumption. Most applications have some application states that require an output power below 25 percent of nameplate. Additionally, many applications spend a significant portion of time in these states. However, at these low power levels, the efficiency of an EPS is relatively low. Because of this situation, DOE does not intend to use the active-mode efficiency metric alone.

Instead, DOE will calculate energy consumption in this region by interpolating between two known points: (1) the no load power consumption and (2) the active mode consumption at 25 percent of nameplate output power. These are points 1 and 2 in Figure 6.3. At an output power of 25 percent, the energy consumed by the EPS is: $P_{Consumed} = P_{Out} \times (1/\eta - 1)$. At an output power of 0 percent (no load mode), the energy consumed by the EPS is: $P_{Consumed} = P_{NL}$. Given these two known values, DOE assumed that the energy consumed by an EPS at an output power between 0 and 25 percent of nameplate output power must fall on a curve between these two points.

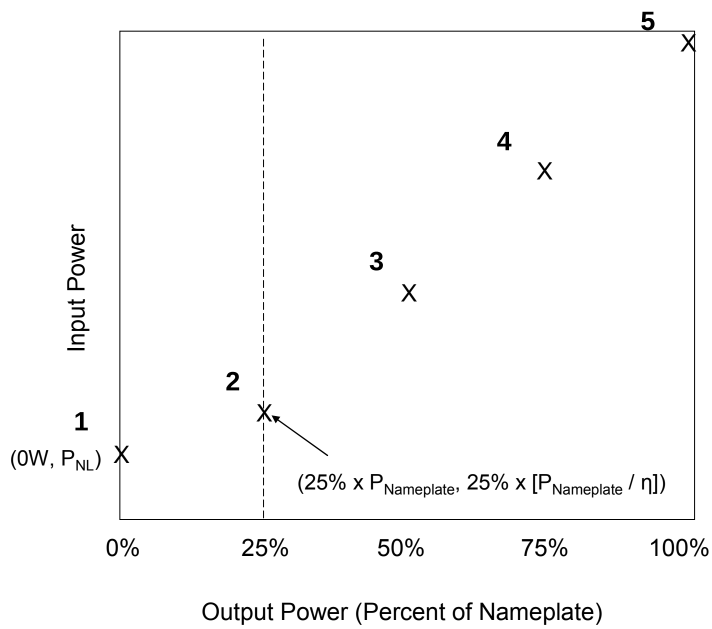

Figure 6.3. Relationship Between EPS Input Power and Output Power at Five Loading Points

DOE approximated this curve with a straight line between points 1 and 2, which can be described by the following equation relating input power to output power:

$$P_{In} = m \times P_{Out} + B$$

Where B is the y-axis intercept, or P_{NL}, and m is the slope, or:

$m = \Delta y/\Delta x$
$m = [(25\% \times [P_{Nameplate} / \eta]) – P_{NL}] / [(25\% \times P_{Nameplate}) – 0]$

Thus, for output power levels below 25 percent nameplate output power, the input power of the EPS is:

$$P_{In} = \{[(25\% \times [P_{Nameplate} / \eta]) – P_{NL}] / [25\% \times P_{Nameplate}]\} \times POut + P_{NL}$$

Since

$$P_{Consumed} = P_{In} – P_{Out}$$

Then

$$P_{Consumed} = \{[(25\% \times [P_{Nameplate} / \eta]) – P_{NL}] / [25\% \times P_{Nameplate}]\} \times P_{Out} + P_{NL} – P_{Out}$$

Or

$$P_{Consumed} = (\{[(25\% \times [P_{Nameplate} / \eta]) – P_{NL}] / [25\% \times P_{Nameplate}]\}-1) \times P_{Out} + P_{NL}$$

DOE seeks comment on its proposed methodology for calculating energy consumption at output power levels below 25 percent of nameplate output power.

6.2.3 Calculating EPS Energy Use

Unlike most other consumer products using electricity, the energy consumption of an EPS cannot always be measured as the energy drawn from mains, since the function of an EPS is to deliver power for the operation of other end-use applications. DOE intends to calculate the energy consumption of an EPS (E_{CON}) as the difference between energy drawn from mains (E_{IN}) and the energy supplied to the end-use application (E_{OUT}), or:

$$E_{CON} = E_{IN} - E_{OUT}$$

Since energy measures power (P) multiplied by a duration of time (T), the following equation is used:

$$P_{CON} * T = (P_{IN} – P_{OUT}) * T$$

Factoring in the different EPS modes:

$$P_{CON} * T_{TOTAL} = P_{CON\text{-}Active} * T_{Active} + P_{CON\text{-}No\text{-}Load} * T_{No\text{-}Load}$$

Further factoring in application states:

$$\begin{aligned} P_{CON} * T_{TOTAL} = \; & P_{CON\text{-}Active1} * T_{Active1} + \\ & P_{CON\text{-}Active2} * T_{Active2} + \\ & P_{CON\text{-}Active3} * T_{Active3} + \\ & \ldots \\ & P_{CON\text{-}No\text{-}Load} * T_{No\text{-}Load} \end{aligned}$$

Thus, to calculate the energy consumption of an EPS, DOE will combine the time values (from usage profiles) with power consumption values.

In its determination analysis, DOE did not differentiate between energy consumption of the EPS power levels above and below 25% of nameplate output power. Instead, DOE estimated a capacity factor, which is a single value expressed as the time-averaged ratio of actual output power during active mode divided by the nameplate output power. Capacity factor is described in detail in section 6.3.2.3 of the draft technical report. DOE does not intend to use capacity factor in this rulemaking. Rather, DOE believes the methodology described in this framework document will more accurately model EPS energy consumption. DOE invites stakeholder comment on this matter.

Section 6.3 of the draft technical report lists usage profiles and unit energy consumption estimates for the following EPS-powered applications:

Camcorders	Laptop computers
Cordless telephones	Portable audio players
Digital cameras	Portable gaming devices
Flat panel monitors	Portable video players
Flatbed scanners	Small liquid crystal display (LCD) TVs
Ink-jet computer printers	Telephone answering devices
Local area network (LAN) equipment	Wi-Fi access points
Medical devices	Wireless telephones
Modems/fax modems	

Item 49 *DOE requests comment on its proposed methodology for calculating energy consumption at each application state under EPS active mode.*

Item 50 *DOE requests comments on its proposed methodology for calculating energy consumption at output levels below 25 percent of nameplate output power.*

6.3 Off-Mode Energy Consumption

EISA directs DOE to consider off mode energy consumption and defines this mode as the state when a device is connected to a main power source and not providing any standby or active mode function. In a separate rulemaking, DOE established that off mode only applies to those BCs and EPSs that have manual on-off switches (see 74 FR 13318). For BCs, off mode is the condition in which the charger is connected to mains power, the charger is not connected to the battery, and all switches on the device are in the off position. For EPSs, off mode is the condition in which the EPS is connected to mains power, the EPS is not attached to a load, and all switches on the device are in the off position.

Because the inclusion of on-off switches on BCs and EPSs is uncommon and the frequency with which these switches are used is unknown, DOE assumes that the energy consumption of the device would be zero while in off mode. That is, DOE assumes that the on-off switch controls the power input to the device, and thus switching it off would completely disconnect the device from mains. Therefore, as a simplification, DOE is proposing to include any time the device spends in off mode as part of the time the device spends in unplugged mode.

Item 51 *DOE requests comments on its proposal to associate off mode with unplugged mode for the purposes of calculating energy consumption. DOE also requests comments on time spent in off mode, as well as power consumption while in off mode.*

7 PRODUCT PRICE DETERMINATION

As stated in section 5, the purpose of the engineering analysis and product price determination is to understand the relationship between end-user price and efficiency for BCs and EPSs. Because DOE needs a retail (consumer) price for each efficiency level used in the LCC and PBP analysis and the national impact analysis, DOE will start with manufacturer selling price (MSP) estimates and study the distribution value chain for BCs and EPSs moving from manufacturer to end-user. From that analysis, which includes volume estimates and typical markups applied by interested parties in the distribution chain, DOE will then calculate a manufacturer-to-retail markup to convert MSP estimates to retail price estimates. DOE will also develop a sales tax estimate and apply it to the retail price estimates to arrive at end-user product prices.

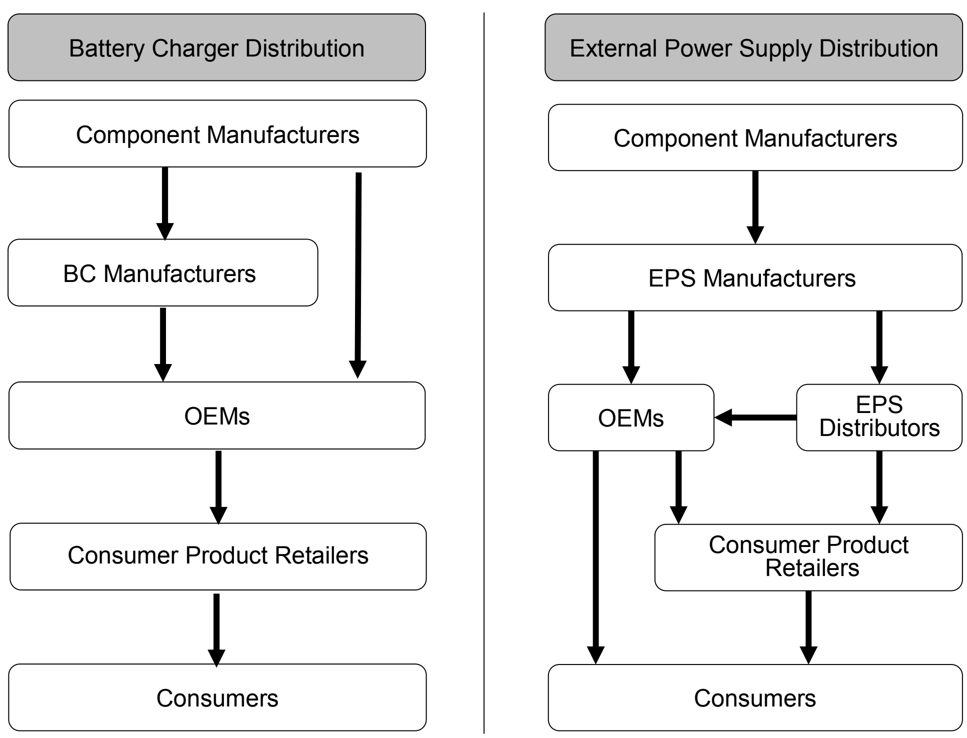

Figure 7.1. BC and EPS Distribution Networks

Figure 7.1 shows the paths that BCs and EPSs typically take to market. Section 3.3.1 discusses this distribution network in more detail. DOE estimates MSPs in its engineering analysis. For EPSs, OEM markups are then applied to the MSPs to arrive at the price to the retailer. To estimate the OEM markups, DOE will use publicly available data on the gross margins of major manufacturers. For BCs, DOE does not intend to derive separate OEM markups, because a single company will typically manufacture both a BC and the end-use application it powers.

DOE will estimate retailer markups using publicly available data on the gross margins of major retailers of electronic and electrical products. When applying the retailer markups to arrive at pre-tax consumer prices, DOE will consider that some fraction of BCs and EPSs are not sold through a retailer but sold directly from the OEM to consumers.

The sales tax represents state and local sales taxes and is a multiplicative factor that increases the end-user product price. DOE will obtain information on state and local sales tax from the Sales Tax Clearinghouse.[29] These data will be compiled to calculate a national, population-weighted average sales tax as well as a population-weighted average tax for each Census division. The national-level sales tax figures will be used in the LCC, PBP (both discussed in section 8), and NPV (section 10) analyses, while the Census division-level tax figures may be used in life-cycle cost subgroup analyses (section 11).

DOE has created initial estimates of manufacturer-to-consumer markups for BCs and EPSs. These estimates, shown in Table 7.1 and Table 7.2, are based on assumptions about how BCs and EPSs are sold (*i.e.*, product grouping and distribution channels). Chapter 7 of the draft technical report explains these underlying assumptions in detail.

DOE has grouped BCs and EPSs as the tables show merely for convenience of presentation. DOE is not proposing product classes at this time. If DOE adopts different product classes in the preliminary analyses, it will develop new estimates of the distribution chain markups for those classes. Section 3.6 discusses product classes, and comments from interested parties on this issue are welcome.

Table 7.1. BC Manufacturer-to-Consumer Markups

	Battery Voltage			
	0 to ≤ 3 V	**>3 to ≤ 9 V**	**> 9 V Slow Charging**	**>9 V Fast Charging**
OEM Markup	1.00	1.00	1.00	1.00
Retailer Markup	1.37	1.45	1.51	1.51
Sales Tax	1.069	1.069	1.069	1.069
Total Markup	*1.46*	*1.55*	*1.61*	*1.61*

Note: Total markup equals the product of the three markups. Multiplying the manufacturer selling price by the total markup yields the consumer purchase price. Column groupings represent past analysis and are provided as examples; products may be grouped differently in future analyses.

[29] The Sales Tax Clearinghouse, Inc., was established in August 1999 to facilitate the calculation of sales and use taxes administered by the Nation's 7,000 taxing authorities at the State, county, and city levels. Information on the Sales Tax Clearinghouse can be found at www.thestc.com.

Table 7.2. EPS Manufacturer-to-Consumer Markups

	Nameplate Output Power		
	0 to < 4 W	**≥ 4 to ≤ 60 W**	**> 60 W**
OEM Markup	1.43	1.43	1.36
Retailer Markup	1.31	1.31	1.31
Sales Tax	1.069	1.069	1.069
Total Markup	*2.00*	*2.00*	*1.90*

Note: Total markup equals the product of the three markups. Multiplying the manufacturer selling price by the total markup yields the consumer purchase price. Column groupings represent past analysis and are provided as examples; products may be grouped differently in future analyses.

Take, for example, low-voltage BCs, whose battery voltage is less than or equal to 3 volts. The manufacturer selling prices DOE used as inputs in its preliminary analysis for BCs represent the prices at which BCs are sold to retailers. Because there is no separate OEM markup, it appears as 1.00 in Table 7.1. DOE found that the principal retailers of products that incorporate low-voltage BCs have an average markup of 37 percent or 1.37. The Sales Tax Clearinghouse reported a national average sales tax of 6.9 percent or 1.069. Multiplying these markups gives a total markup of 46 percent, or 1.46, for low-voltage BCs. DOE used the same process to arrive at manufacturer-to-consumer markups for other BCs and for EPSs. Chapter 7 of the draft technical report provides additional detail, including the data from which DOE derived the preliminary markups.

Item 52 *DOE seeks comments on all aspects of the product price determination for BCs and EPSs, including assumptions about the percent of shipments passing through each distribution channel and the markups associated with each channel.*

8 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES

This section describes the Department of Energy (DOE)'s methodology for analyzing the economic impacts of possible energy efficiency standards on individual consumers. The effect of standards on individual consumers includes a change in operating expense (usually decreased) and a change in purchase price (usually increased). This section describes three metrics DOE uses in the consumer analysis to determine the effect of standards on individual consumers:

- *Life-cycle cost (LCC)* is the total consumer expense over the life of a product, including purchase expense and operating costs (including energy expenditures). DOE discounts future operating costs to the time of purchase, and sums them over the lifetime of the equipment;

- *Payback period (PBP)* measures the amount of time it takes customers to recover the assumed higher purchase price of more energy-efficient equipment through lower operating costs; and

- *Rebuttable payback period* is built on a rebuttable presumption that an energy conservation standard is considered economically justified if "the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy. . . savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. . . ." (42 U.S.C. 6295(o)(2)(B)(iii))

DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which include, but are not limited to, the three-year payback period contemplated under the rebuttable presumption noted above. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level.

Because the test procedures codified in 10 CFR Part 430, Subpart B, Appendices Y and Z measure the energy efficiency of BCs and EPSs, and not actual energy consumption, DOE must analyze the effect on consumers of BCs and EPSs by calculating the LCC and PBP using data from the engineering analysis (section 5), the energy-use and end-use load characterization (section 6), and the product price determination (section 7).

When calculating the LCC, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment, as shown in the following equation:

$$LCC = IC + \sum_{t=1}^{N} \frac{OC_t}{(1+r)^t}$$

where:

LCC =	life-cycle cost in dollars,
IC =	total installed cost in dollars,
∑ =	sum over the lifetime, from year 1 to year N,
N =	lifetime of product in years,
OC =	operating cost in dollars,
r =	discount rate, and
t =	year for which operating cost is being determined.

For BCs and EPSs, DOE conducted some preliminary work on the LCC as part of its determination analysis directed by EPACT 2005. The text that follows discusses some of these inputs and methodologies that DOE was developing when the determination analysis was rescheduled. One of the initial decisions DOE made for the LCC was to focus the analysis on the use of BCs and EPSs in the residential sector, rather than the commercial or industrial sectors. The scope of coverage for these rulemakings encompasses BCs and EPSs designed for consumer products, such as cellular telephones, laptop computers, portable music players, digital cameras, power tools, hand-held vacuum cleaners, and so on. While DOE recognizes that commercial and industrial entities use these products, and the BCs and EPSs that power them, it believes that the residential sector uses a considerable majority of the products in service today. For this reason, DOE is considering focusing its preliminary LCC analysis on the residential sector.

Item 53 *DOE seeks comments on its intention to focus its preliminary LCC analysis on the residential sector, and not the commercial or industrial sectors.*

8.1 Life-Cycle Cost and Payback Period Methodology

For the draft determination analysis, DOE developed an LCC methodology based on the approach followed in other rulemakings, tailored for some unique aspects of BCs and EPSs. For example, while the equation above mentions “total installed cost” in its list of LCC input variables, DOE considers installation costs to be zero because they would typically entail a consumer simply unpacking the BC or EPS from the box it was sold in and connecting the device to mains power and its associated product or battery. Because the cost of this “installation” (which may be considered temporary, as intermittently used devices might be unplugged for storage) is not quantifiable in dollar terms, DOE considers the installation cost to be zero. Therefore, the total installed cost would be the retail price of the product paid by the consumer.

Similarly, DOE considers repair and maintenance costs (which are typically associated with larger products and appliances) to be zero. In making this decision, DOE recognizes the reality of the marketplace, where the service life of a BC or EPS typically exceeds that of the consumer product with which it is designed to operate. A consumer would not incur repair or maintenance costs for a BC or EPS. Also, if a BC or EPS did fail, consumers would typically discard the device and purchase a replacement BC or EPS.

In Figure 8.1, DOE presents its flow diagram for the draft determination analysis LCC developed in 2007. The figure depicts, from left to right, LCC inputs in yellow boxes, interim calculated values in green boxes, and final output values (*i.e.*, LCC and PBP) in blue boxes.

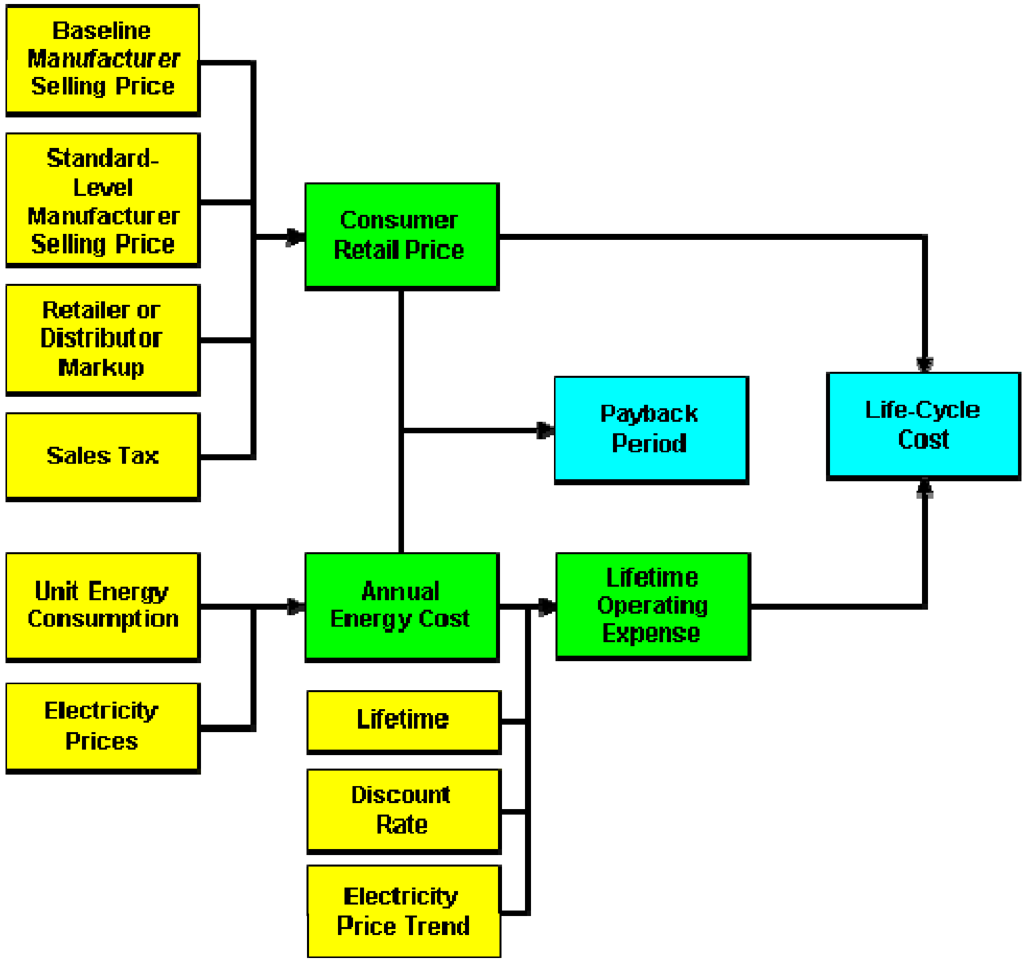

Figure 8.1. Flow Diagram of Inputs for the Determination of LCC and PBP

Under 42 U.S.C. 6295(o)(2)(B)(iii), the statute establishes a rebuttable presumption that a standard is economically justified "[i]f the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy . . . savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. . . ." DOE's LCC and PBP analyses generate values that indicate the cost-effectiveness of products meeting potential energy conservation standards. These values include, but are not limited to, the 3-year payback period contemplated under the rebuttable presumption test discussed above. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this full analysis serve as the basis for DOE to definitively determine the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

DOE intends to conduct the preliminary LCC and PBP analyses using typical values for equipment retail price, operating life, electricity costs, electricity consumption, and discount rates. If DOE determines that there is significant variability in any of these inputs, it will conduct sensitivity analyses to determine how the LCC and PBP are affected by high and low estimates of each input. For any sensitivity analyses that it conducts, DOE will account for correlations that may exist between inputs (*e.g.*, electricity usage may be correlated to electricity prices). The detailed impact calculation, which DOE will conduct during the NOPR stage of the rulemaking, may include an assessment of impacts on subgroups of consumers, as described in section 11 of this framework document.

For the NOPR, DOE will carefully review all the comments it receives on the preliminary LCC analysis, make any necessary revisions, and evaluate additional parameters not included in the preliminary analysis if necessary.

8.2 Life-Cycle Cost and Payback Period Inputs

As discussed above, DOE conducted some preliminary work in developing its LCC for the determination analysis. The LCC methodology described above and the inputs presented in Table 8.1 are based on approaches that DOE developed for other energy conservation standards rulemakings. The draft inputs are presented here for review and comment by interested parties.

In its LCC analysis, DOE noted that BCs and EPSs are most commonly sold as components of consumer products. That is, the BC or EPS works as an enabling part of a system, converting mains electricity to charge a battery or operate a product. Thus, the retail price of a BC or EPS is bundled with the retail price of the consumer product (*e.g.*, cellular telephone, laptop computer, digital camera). To determine appropriate retail prices for BCs and EPSs, DOE reviewed distributor catalogs and interviewed manufacturers familiar with the supply chain. As section 7 discusses, DOE used product price determination and supply chain markups to calculate product price inputs. These product prices (detailed in section 8.3.1 of the draft technical report) varied significantly depending on the capacity of the device and its efficiency.

Table 8.1 presents the draft inputs that DOE developed in 2007 for the determination analysis. Section 8.3 of the draft technical report provides further detail on the derivation of and sources for these inputs.

Table 8.1. Draft Inputs to the Life-Cycle Cost and Payback Period Analyses

Input	Description	Average or Typical Value	Sources
Product Price	The retail price before tax (*i.e.*, bundled with a consumer product). Based on a manufacturer selling price marked up through the distribution chain.	Varies	Distributor catalogs, high-volume price estimates, manufacturer interviews.
Sales Tax	Used to convert the product price to a final consumer retail price including sales tax.	6.9%	Weighted average of sales tax in 13 geographic regions and large states.
Unit Energy Consumption	The annual on-site electricity consumption associated with a BC or EPS.	Varies	Developed in section 6, Energy-use and End-use Load Characterization.
Electricity Prices	The national residential sector average price per kilowatt-hour (*i.e.*, $/kWh).	$0.097/kWh in 2005	Energy Information Administration (EIA).
Electricity Price Trends	Projects changes in the price of electricity over the analysis period. Includes a high and low scenario.	Varies	The Annual Energy Outlook from the EIA.
Product Lifetime	The total years in use after which the consumer retires the BC or EPS from service. The BC or EPS may be retired before the end of its useful life if the consumer product it operates is retired from service.	3 - 5 years	Discussed in section 8.2.3.
Discount Rate	The rate DOE estimates to be representative of BC and EPS consumers, used to discount future expenditures and establish their present value.	5.6%	Weighted average of residential financing methods, discussed in section 8.2.2.
Analysis Period	The time period over which DOE calculates the LCC.	Product lifetime	Discussed in section 1.5.

8.2.1 Electricity Prices

For residential consumers of BCs and EPSs, DOE plans to use projections of national average electricity prices from Energy Information Administration's (EIA) *Annual Energy Outlook* (AEO) for the most recent year available. In other rulemakings, DOE has calculated a shipment-weighted average electricity price, based on inventories of products developed through the EIA's Residential Energy Consumption Survey. However, the survey did not include questions on inventories of BCs and EPSs, and therefore, DOE is unable to create a national installed-base-weighted average electricity price. Instead, DOE proposes to use the national average electricity price, as published by EIA.

To ascertain the sensitivity of the LCC to future electricity price trends, in addition to the reference case, DOE will evaluate the LCC using both the low and high economic growth cases.

Together, these three cases reflect the uncertainty in electricity prices over the analysis period. Figure 8.2 presents the residential electricity price trends (in constant 2007$), based on *AEO 2007* projections.

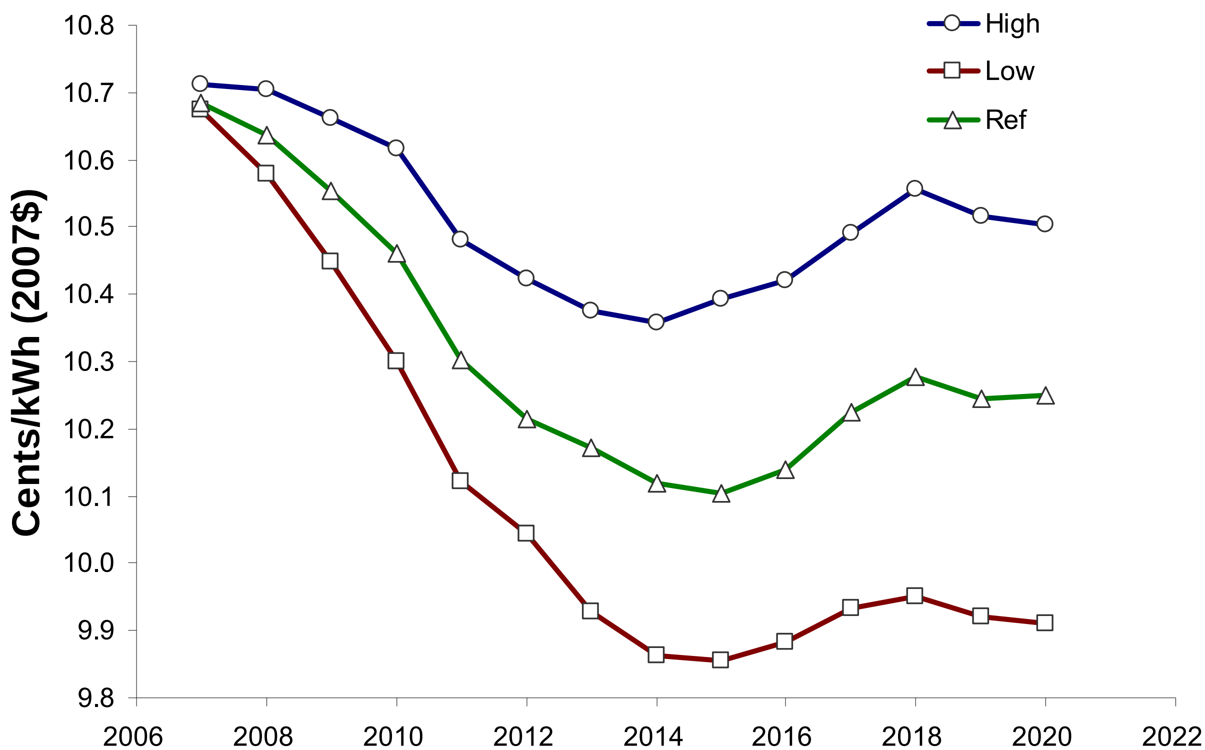

Figure 8.2. *AEO 2007* Residential Electricity Price Trend Forecast

Item 54 *DOE seeks comments on the use of the EIA national average electricity price and the AEO forecast of electricity prices over the analysis period.*

8.2.2 Life-Cycle Cost Discount Rates

Discounting reflects the current value of money spent or saved in the future. As discussed previously, calculation of consumer LCC requires DOE to use a discount rate to determine the present value of the money the consumer would spend to operate the BCs and EPSs over the products' lifetime. Because consumers can use a variety of financial means to purchase a BC or EPS, the discount rate should equal the average cost of capital to the consumer. DOE assumes these financial means, listed in Table 8.2, to be similar to the ones consumers use when purchasing and financing replacement appliances for the home.

For the draft determination analysis, DOE acknowledged the similarity between households financing replacement appliances and purchasing BCs and EPSs, and therefore adapted the LCC discount rate derivation from the home appliances rulemaking to its draft analysis. DOE's approach involved identifying all possible debt or asset classes that consumers might use to purchase replacement equipment, including household assets that might be affected indirectly.

DOE estimated the shares of the various debt and equity classes in the typical U.S. household portfolio using the Federal Reserve's *Survey of Consumer Finances* (*SCF*) data for 1989, 1992, 1995, 1998, 2001, and 2004. DOE also used *SCF* data to determine rates of return for each class. DOE then calculated an average rate weighted by the share of each class of debt or equity, equal to 5.6 percent, to represent a household discount rate. For more detail on the data sources, methodology, and calculation of the residential discount rate, please see section 8.3.4 of the draft technical report.

Table 8.2. Shares and Interest or Return Rates Used for Household Debt and Equity Types

Type	Average Share of Household Debt Plus Equity (%)*	Mean Real Effective Discount Rate (%)**
Home equity loans	3.6	4.0
Credit cards	2.0	11.0
Other installment loans	1.7	6.0
Other residential loans	4.9	4.6
Other line of credit	0.5	8.7
Checking accounts	4.5	0.0
Savings and money market accounts	15.7	2.3
Certificates of Deposit	9.0	2.4
Savings bonds	1.5	3.5
Bonds	10.0	4.2
Stocks	29.1	8.8
Mutual funds	17.5	7.0
Total/weighted-average discount rate	100.0	**5.6.0**

* Not including primary mortgage or retirement accounts.

** Adjusted for inflation and, for home equity loans, loan interest tax deduction.

Item 55 *DOE seeks comments on the methodology to be used for calculating residential discount rate used in the LCC analysis.*

8.2.3 BC and EPS Operational Lifetimes

DOE intends to use information from manufacturer product catalogs, various literature sources such as technical reports and conference proceedings, and input from manufacturers and other interested parties to establish BC and EPS lifetimes for use in the LCC and subsequent analyses.

As discussed earlier in this section, because BCs and EPSs are often made specifically for use with particular consumer products, their lifetimes relate directly to the lifetimes of those products. DOE assumes that once the consumer product has reached the end of its useful life, the user typically discards the associated BC or EPS. Therefore, for each group of BCs and EPSs, DOE has gathered lifetime values for consumer product applications and combined them with shipment estimates to derive a shipment-weighted average lifetime representative of the group. Table 8.3 and Table 8.4 display the shipment-weighted average lifetimes that DOE derived during its preliminary work. These results are from DOE's initial analysis and may change depending on the product classes used in the preliminary analysis.

Table 8.3. Shipment-Weighted Average Lifetimes for Battery Chargers

	Battery Voltage			
	0 to ≤ 3 V	**> 3 to ≤ 9 V**	**> 9 V Slow Charging**	**> 9 V Fast Charging**
Lifetime	3 years	5 years	5 years	5 years

Table 8.4. Shipment-Weighted Average Lifetimes for External Power Supplies

	Nameplate Output Power		
	0 to < 4 W	**≥ 4 to ≤ 60 W**	**> 60 W**
Lifetime	4 years	5 years	4 years

To see the lifetimes of specific consumer product applications, please refer to section 8.3.5 of the draft technical report. Based on consideration of the comments received on this framework document, DOE will make necessary changes to the analysis. These changes will be reflected in the preliminary TSD.

Item 56 *DOE seeks comments on appropriate lifetimes for the BCs and EPSs covered in this rulemaking.*

The following is a list of the sources of BC and EPS lifetime data DOE has identified to date:

- "30th Annual Portrait of the U.S. Appliance Industry." *Appliance Magazine*. September 2007.
- U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. "FY2005 Preliminary Priority-Setting Summary Report and Actions Proposed. Appendix A: FY2005 Technical Support Document. Table A9-1: Background Data on Battery Chargers and Power Supplies." (Last accessed March 3, 2006.) www.eere.energy.gov/buildings/appliance_standards/pdfs/fy05_priority_setting_app_a.pdf.
- TIAX LLC. "Assessment of Analyses Performed for the California Energy Efficiency Regulations for Consumer Electronics Products." February 2006. TIAX LLC: Cambridge, MA.

Item 57 *DOE seeks input on additional sources for the lifetimes of BCs and EPSs and comments on the application lifetimes provided in section 8.3.5 of the draft technical report.*

9 SHIPMENTS ANALYSIS

DOE develops shipment forecasts of products to calculate the national impacts of standards on energy consumption, NPV, and future manufacturer cash flows. DOE plans to develop shipments forecasts based on an analysis of key market drivers for BCs and EPSs. Principal among these drivers is demand for the consumer products that use BCs and EPSs.

9.1 Base Case Forecast

To evaluate the various impacts of standards, DOE develops a base case shipments forecast against which it compares standards case shipments forecasts at higher CSLs. DOE will design the base case forecast to depict what it anticipates would happen to energy consumption and energy costs over time if energy conservation standards for the units covered under this rulemaking are not adopted. In determining the base case forecast, DOE will consider historical shipments, the mix of BC and EPS efficiencies currently sold, and how that mix might change over time if new standards are not adopted. For these purposes, DOE needs data on historical equipment shipments and the market shares of the different efficiency levels offered in each product class.

In its work on the determination, DOE estimated that in 2007, 69,562,200 battery chargers and 397,200,000 external power supplies were sold in the United States. Using its data on total shipments of applications, DOE divided these shipments into groups according to voltage for BCs and nameplate output power for EPSs. To divide BC shipments into product groups, DOE used input from the Association of Home Appliance Manufacturers (AHAM) and the Power Tool Institute (PTI). DOE estimated distributions for EPSs based on the work of TIAX[30] and the Darnell Group.[31] Table 9.1 and Table 9.2 show the distribution of shipments by product grouping for BCs and EPSs. For a more detailed description of how DOE estimated shipments of BCs and EPSs, see chapter 9 of the draft technical report.

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[30] TIAX LLC. *Assessment of Analyses Performed for the California Energy Efficiency Regulations for Consumer Electronics Products*. TIAX LLC: Cambridge, MA. February 2006.

[31] Darnell Group. *External AC-DC Power Supplies: Global Market Forecasts and Competitive Environment.* Second Edition. Darnell Group: Corona, CA. 2005.

Table 9.1. Battery Charger Shipments by Product Group in 2007

	Battery Voltage			
	0 to ≤ 3 V	> 3 to ≤ 9 V	> 9 V Slow Charging	> 9 V Fast Charging
Shipments (millions)	5.14	41.71	11.36	11.36

Table 9.2. External Power Supply Shipments by Product Group in 2007

	Nameplate Output Power		
	0 to < 4 W	≥ 4 to ≤ 60 W	> 60 W
Shipments (millions)	112.2	249.5	35.5

> ***Item 58*** *DOE seeks recommendations on sources of data on shipments of BCs and EPSs by product group.*

DOE also hopes to understand the breakdown of efficiency levels within each group of BCs or EPSs on which analyses are performed (*i.e.*, data on the distribution of shipments by efficiency). DOE is considering using the efficiency distributions shown in Table 9.3 for BCs and Table 9.4 for EPSs. Because very little information is available about the distribution of shipments by efficiency for BCs and EPSs, DOE reports these distributions with some uncertainty and encourages comments on alternative distributions.

To estimate the distribution of BCs by efficiency, DOE based its analysis on a subset of a large dataset published by the California Energy Commission (CEC).[32]

Table 9.3. Base Case Distribution of BC Shipments Across Efficiency Levels by Product Group in 2007

Percentage of Market at Efficiency Level*	Battery Voltage			
	0 to ≤ 3 V	> 3 to ≤ 9 V	> 9 V Slow Charging	> 9 V Fast Charging
Baseline	60	45	65	65
Slightly Improved	20	13	10	10
CEC Tier 1/ENERGY STAR	13	26	10	10
Beyond Standard	0	10	15	15
Best-in-Market	7	6	0	0
All Levels	**100**	**100**	**100**	**100**

*Efficiency levels are discussed in section 5.2.

To estimate the current year's efficiency distribution of EPSs for its determination analysis, DOE used a Pacific Gas and Electric study. The study estimated that in 2004, 40

[32] Blosser, J., H. Kameth, et al. *Battery Charger Laboratory Test Data File*. California Energy Commission Public Interest Energy Research Funding. 2006.

percent of EPSs met CEC Tier 1 standards and 25 percent met CEC Tier 2 standards.[33] DOE used these estimates and the EPA ENERGY STAR Qualified Products List to arrive at a distribution of EPS shipments across efficiency levels for each product group,[34] discussed in depth in section 9.1.2 of the draft technical report. DOE recognizes that this information may be outdated and may change dramatically with the standards imposed by EISA. DOE seeks input on sources of current data on this subject.

Table 9.4. Base Case Distribution of EPS Shipments Across Efficiency Levels by Product Group in 2007

Percentage of Market at Efficiency Level*	Nameplate Output Power		
	0 to < 4 W	**≥ 4 to ≤ 60 W**	**> 60 W**
Baseline Linear	35	16	0
Baseline Switched-Mode EPS	25	44	60
CEC 1/ENERGY STAR	15	15	15
CEC 2	12	6	9
> CEC 2	10	18	5
Market Best	3	1	11
Max Tech	0	0	0
All Levels	**100**	**100**	**100**

*Efficiency levels are discussed in section 5.2.

DOE intends to use two approaches to characterize changes in efficiency of both BCs and EPSs over time in the absence of new standards. In the static approach, the efficiency distribution does not change over time in the absence of a new standard. In the dynamic approach, efficiency improves progressively over time, even after a new standard takes effect. DOE uses these two approaches to provide an upper and lower bound, respectively, for calculated energy savings from improvements in energy efficiency. These improvements may be spurred by changes in technology, voluntary programs such as the ENERGY STAR program, consumer preferences, and other market forces. See section 9.2 of the draft technical report for a more detailed discussion of DOE's proposed approaches to forecasting changes in efficiency over time.

Item 59 *DOE seeks recommendations on sources of data that would provide accurate and up-to-date information on BC and EPS efficiency distributions within product groups. DOE also seeks comments on how it might characterize long-term trends in the efficiency of BCs and EPSs for its base case shipments forecasts.*

[33] Fenstrom, Gary. "Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development Analysis of Standards Options for Single-Voltage External AC to DC Power Supplies." Prepared by Ecos Consulting, Davis Energy Group, and Energy Solutions for Pacific Gas and Electric. May 2004.

[34] Environmental Protection Agency. "Qualified Product (QP) List for ENERGY STAR® Ac-Dc Qualified External Power Supplies." www.energystar.gov/ia/products/prod_lists/eps_ac_dc_prod_list.pdf. Accessed December 17, 2007.

DOE intends to prepare shipment forecasts for the base case. The model will keep track of the aging and replacement of BCs and EPSs given product lifetimes (section 8.2.3) and a projection of future BC and EPS sales growth. The shipments growth rate for many applications using BCs and EPSs is quite high. This is especially true for higher-powered EPS applications. DOE is considering using the constant annual growth rates in Table 9.5 as reference values. However, as the market for these goods becomes more saturated, growth rates may slow. DOE seeks comments on whether growth rates that decline over time would be more appropriate and what those growth rates should be for purposes of DOE's analysis.

Table 9.5. Base Case Shipments Growth Rates for BCs and EPSs

	All BCs	EPSs by Nameplate Output Power		
		0 to < 4 W	≥ 4 and ≤ 60 W	> 60 W
Compound Annual Growth Rate (%)	4	2	3	4

Note: DOE may use separate growth rates for each BC product group.

Item 60 *DOE seeks comments on appropriate shipment growth rates.*

9.2 Standards Impacts on BC and EPS Shipments

DOE will develop a set of shipment forecasts for each set of efficiency standards analyzed. These standards case forecasts will help DOE evaluate the impacts of standards on BC and EPS shipments and therefore on the energy consumption of BCs and EPSs. DOE derives standards case forecasts using the same data sets it used for the base case forecasts. However, because the standards case forecasts account for the increase in purchase price and the decrease in operating costs caused by standards, forecasted shipments typically deviate from the base case. The magnitude of the difference between the standards case and base case shipment forecasts depends on the calculated purchase price increase, as well as the operating cost savings from the standard. Because the purchase price tends to have a larger impact than operating cost on equipment purchase decisions, standards case forecasts typically show elasticity of demand, manifested as a drop in shipments relative to the base case. However, in the case of BCs and EPSs, the demand may be inelastic if the cost of BCs and EPSs does not increase much relative to the cost of the application.

Another market response to the presence of a standard for BCs or EPSs is to substitute a different power source for the BC or EPS. Possible substitute sources may include internal power supplies, external power supplies (for BCs), primary batteries, rechargeable batteries (for EPSs), and USB systems, among others. The extent to which manufacturers choose substitute power sources may be limited by design constraints. For example, in some cases, using an internal power supply makes an application less portable. Another substitute, USB power, is limited because USB ports are much less common than traditional wall outlets. In its preliminary analysis, DOE assumed that the demand for BCs and EPSs is inelastic; that is, price increases in the standards case lead to no decrease in demand for the product. DOE seeks comments on the price elasticity of demand for BCs and EPSs.

Item 61 *DOE seeks input on the sensitivity of BC and EPS demand to changes in price.*

In addition to quantifying the projected impact of standards on total shipments, DOE must also quantify the change in the mix of product efficiencies due to standards. DOE is considering two market reactions: shift and rollup. In the shift scenario, all products become more efficient in response to a standard, even those that were more efficient than the standard. In the rollup scenario, those products that do not meet the standard become just efficient enough to meet the standard but not exceed it, while the products that were already more efficient than the standard remain unaffected. These two standards case scenarios will be used in combination with the static and dynamic base case scenarios discussed above in section 9.1. See section 9.3 of the draft technical report for a more detailed discussion of DOE's proposed approach to forecasting the effects of standards on shipments.

Market-pull programs such as the ENERGY STAR program and consumer rebate programs that encourage the purchase of more efficient BCs and EPSs also affect standards case forecasts. When such programs exist, DOE will consider their impacts on shipments.

Item 62 *DOE seeks comments on how any new energy conservation standard for BCs and EPSs might affect shipments of these products. DOE specifically seeks comments on its rollup and shift scenarios, as discussed in section 9.3 of the draft technical report.*

10 NATIONAL IMPACT ANALYSIS

The national impact analysis reflects DOE's assessment of the aggregate impacts of potential efficiency standards at the national level. Measures of impact that DOE will report include future NES from CSLs (*i.e.*, the combined incremental energy savings from a new or increased energy conservation standard relative to a base case of no change in the energy conservation national standard over a specified forecast period) and the NPV from CSLs (*i.e.*, the combined incremental LCC from a new or increased energy conservation state relative to the base case over a specified forecast period).

10.1 Inputs to Forecasts

Analyzing impacts of Federal energy conservation standards for BCs and EPSs requires comparing projected energy consumption in the United States with and without new energy conservation standards. The forecasts contain projections of unit energy consumption of BCs and EPSs, annual shipments, the price of purchased units, and base case and standards case efficiencies. Section 6 discusses approaches to determine unit energy consumption while section 7 discusses approaches to determine retail prices for equipment. Section 9 discusses the derivations of the base case shipments forecasts.

Although improving the energy efficiency of a product would generally lead to lower energy consumption, DOE recognizes other factors that may impact energy consumption:

- *Rebound Effect:* Consumers who encounter lower operating costs associated with a more energy-efficient product frequently use that product more often than a less efficient product. This phenomenon is called the rebound effect. For BCs and EPSs, DOE expects the rebound effect to be negligible because consumers are unlikely to notice the decrease in operating costs that would result from new standards for these products.

- *Associated Application Effect:* BCs and EPSs are distinct from other consumer products regulated by DOE in that their energy consumption is directly tied to the usage of another end-use consumer product. Therefore changes in energy consumption, energy efficiency, or usage of that consumer product may affect the energy consumption of the BC or EPS. Because of the wide range of consumer products included and the absence of any known trend in how consumer product designers respond to more efficient power converters, DOE assumes this effect to be negligible.

- *Consumer Awareness Effect:* Increased awareness of the energy consumption of a BC or EPS in non-active modes may lead to consumers unplugging these devices when not in use. Conversely, decreased heating of the devices due to increased efficiency, may lead to lower perceived energy consumption and less consumer willingness to unplug devices when in standby mode. Because of the wide range of possible consumer reactions and no apparent trend in how consumers respond to more efficient power converters, DOE assumes the effects of individual consumer reactions would effectively cancel each other, leaving a negligible effect.

Item 63 *DOE seeks comments on the impact of the rebound effect, the associated application effect, and the consumer awareness effect on energy consumption of BCs and EPSs. To the extent that commenters can offer reasons and data supporting the adoption of a particular quantitative value for each of these effects, DOE is also interested in this information.*

Table 10.1 describes some of the major inputs DOE is anticipating it will develop for the national impact analysis.

Table 10.1. Inputs to the National Impact Analysis

Input Data	Description of Data Sources
Shipments	Annual shipments developed in section 9.
Stock of BCs and EPSs	This stock is calculated from the service life of BCs and EPSs developed in section 8 and annual shipments developed in section 9.
Effective Date of Standard	2013 for Class A EPSs; TBD for BCs.
Analysis Period	2013 to 2043 (30 years) for Class A EPSs; TBD for BCs.
Base Case Forecasted Efficiency	Distribution of base case shipments by efficiency level over time developed in section 9.
Standards Case Forecasted Efficiency	Distribution of shipments by efficiency level for each standards case over time developed in section 5.2.
Unit Energy Consumption (kWh/yr)	The average energy consumption of a BC or EPS established in the energy-use and end-use load characterization, section 6.
Total Installed Cost	Established in the Product Price Determination, section 7, and the LCC analysis, section 8.
Electricity Price Forecast	Established in the Life-Cycle Cost Analysis, section 8.
Electricity Site-to-Source Conversion	Conversion varies yearly and is generated by EIA *Annual Energy Outlook* forecasts of electricity generation and electricity-related losses.
Discount Rate	The discount rate is the rate at which DOE discounts future expenditures to establish their present value. To comply with OMB requirements, DOE will use 3 and 7 percent discount rates.
Present Year	Future costs and savings will be discounted to the year the analysis is performed.
Rebound Effect	The difference between the projected and actual savings due to increased efficiency.

10.2 Calculation of National Energy Savings

DOE intends to calculate NES for each year beginning with the expected effective date of the standards. DOE will calculate these savings as the difference in national electricity consumption between the base case and each CSL analyzed. DOE will perform this calculation using a spreadsheet model that effectively multiplies unit energy savings by the stock of equipment affected by standards. The National Inventory catalogs this stock of equipment.

DOE determines unit energy savings by:

- calculating the weighted-average unit energy consumption (UEC) for a device in the base case, obtained by multiplying the UECs at each efficiency level by the base case forecasted efficiency;
- calculating the weighted-average UEC for a device in the standards case, obtained by multiplying the UECs at each efficiency level by the standards case forecasted efficiency; and
- calculating the difference between the UEC of the base case to the UEC of the standards case, with the difference representing the weighted-average UEC for a device in that year.

The National Inventory represents the rolling stock of EPSs and BCs through the analysis period. It is obtained by adding new shipments each year and removing units after their lifetime has passed. Because the efficiency of new units put in service each year can change over time, the inventory keeps track of the sales year (or vintage) of every unit. The savings generated by the BCs and EPSs of a given vintage accrue over several years. The national energy savings in a given year are actually the sum of the savings from multiple vintages of units.

10.3 Net Present Value

DOE determines the national NPV of energy conservation standards in conjunction with the NES. DOE calculates annual energy expenditures from annual energy consumption by incorporating forecasted energy prices using the shipment and average energy-efficiency forecasts described in section 9. DOE calculates annual equipment expenditures by multiplying the price per unit by the number of units in forecasted shipments. The difference between a base case and a standards case scenario gives the national energy bill savings and increased equipment expenditure in dollars. For the BCs and EPSs rulemakings, this differential will likely result in a NES offset against increased expenditures on BCs and EPSs. The difference each year between energy bill savings and increased equipment expenditures is the net savings (if positive) or net cost (if negative).

DOE will discount these annual values to the present and sum them to provide an NPV. Since the national cost of capital may differ from the consumer cost of capital, the discount rate in the NIA can be different from the rate used in the LCC. Consistent with U.S. Office of Management and Budget (OMB) guidance, DOE will conduct two NPV calculations, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent (OMB, *Circular A-4: Regulatory Analysis*, September 17, 2003). DOE considers the 7-percent and 3-percent real discount rates to be representative of the present value of costs and benefits associated with two types of investments facing an average degree of risk. Specifically, the 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "societal rate of time preference," the rate at which society discounts future consumption flows to their present value.

In calculating national NPV, DOE intends to use the same energy price forecasts it uses in the LCC. However, there is an important difference between the two analyses: in the LCC analysis, residential and commercial consumers are considered separately; however, estimates of national NPV must consider all consumers at once. Thus, DOE calculates national NPV using a weighted-average energy price forecast that considers the proportion of energy savings that accrue to each type of consumer.

> ***Item 64*** *DOE requests comments on the percent distribution of residential and commercial energy use for calculation of the weighted-average energy price.*

In response to comments by interested parties who asked for a simple, transparent model, DOE developed NES/NPV spreadsheet models for its standards rulemakings in 1996. These models project energy savings and demonstrate how to account for efficiency growth over time.[35] Although these models are specific to each product, their general framework is applicable to the BC and EPS markets. DOE expects that the NES/NPV spreadsheet models—one for BCs and one for EPSs—will provide stand-alone forecasts of NES and NPV. Based on the comments DOE receives on this framework document and the preliminary TSD, DOE will make any necessary changes to the analysis and incorporate those changes in the documentation for the NOPR.

> ***Item 65*** *DOE seeks comments on the NES/NPV spreadsheet models that DOE plans to use for estimating national impacts of energy conservation standards for BCs and EPSs. See chapter 10 of the draft technical report for a description of these models.*

11 LIFE-CYCLE COST SUBGROUP ANALYSIS

At the NOPR stage of this rulemaking, DOE will conduct a life-cycle cost subgroup analysis. In this analysis, DOE analyzes consumer impacts by dividing consumers into subgroups and accounting for variations in key inputs to the LCC analysis. A consumer subgroup comprises a subset of the population that is likely, for a variety of reasons, to be affected disproportionately by new or revised energy conservation standards (*e.g.*, small businesses, ethnic minorities, low-income or elderly consumers, etc.).[36] The purpose of a subgroup analysis is to determine the extent of any such disproportional impact. DOE will work with interested parties early in the rulemaking process to identify any subgroups for this consideration. However, as noted above, DOE will not analyze the consumer subgroups until the NOPR stage of the analysis.

In comparing potential impacts on the different consumer subgroups, DOE will evaluate variations in regional electricity prices, usage profiles, and installation costs that might affect the NPV of an energy conservation standard to certain consumer subgroups. To the extent possible, DOE will obtain estimates of the variability in each input factor and consider this variability in its calculation of consumer impacts. DOE will discuss with interested parties the variability in each input factor and likely sources of information.

> ***Item 66*** *DOE seeks comments on which consumer subgroups, if any, DOE should consider when developing standards for BCs and EPSs.*

[35] Several examples of NES spreadsheet models from previous rulemakings can be found on DOE's website at www.eere.energy.gov/buildings/appliance_standards.
[36] For example, consumer subgroups with lower electricity prices than the average consumer will experience lower operating cost savings in the face of a standard, resulting in lower life-cycle cost savings. As another example, low-income consumers may be disproportionately affected by standards that eliminate lower-cost products from the market.

12 MANUFACTURER IMPACT ANALYSIS

As required by section 141 of EPACT 2005, DOE announced changes to the manufacturer impact analysis (MIA) approach in a report issued to Congress on January 31, 2006, titled "Energy Conservation Standards Activities"[37]. Under this new approach, DOE will collect, evaluate, and report preliminary information and data on manufacturer impacts in the preliminary TSD. (See "Energy Conservation Standards Activities," page 48.) Such preliminary information includes the anticipated conversion capital expenditures by efficiency level and the corresponding anticipated impacts on employment. DOE will seek further input on these issues during its manufacturer interviews for the preliminary analyses.

The MIA is designed to assess the potential impacts of energy conservation standards on manufacturers of BCs and EPSs. In addition to financial impacts, a wide range of quantitative and qualitative effects may occur following adoption of a standard that may require changes to the manufacturing practices for these units. DOE will identify these effects through interviews with manufacturers and other experts.

For the NOPR, DOE will supplement the results of the preliminary MIA conducted as part of the preliminary analyses with more detailed analyses (sections 12.1 through 12.5). Specifically, DOE will conduct an industry-wide cash-flow analysis using the Government Regulatory Impact Model (GRIM), identify and analyze subgroups of manufacturers whose business varies significantly from the industry as a whole, perform a competitive impacts assessment, and review the cumulative regulatory burden for the industry.

12.1 Sources of Information for the Manufacturer Impact Analysis

Many of the analyses described earlier provide important information that DOE will use as inputs for the manufacturer impact analysis. Such information includes financial parameters developed in the market assessment (section 3.1), retail price forecasts (section 7), and shipments forecasts (section 9). DOE will supplement this information with information gathered during manufacturer interviews.

DOE will conduct detailed interviews with manufacturers to gain insight into the range of potential impacts from standards. The interview process plays a key role in the manufacturer impact analysis, because it provides an opportunity for directly affected parties to express their views on important issues. During the interviews, DOE will solicit information on the possible impacts on manufacturing costs, equipment prices, sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information are valuable for this analysis. DOE will schedule interviews well in advance to provide every opportunity for key individuals to be available to participate. In addition, DOE will provide manufacturers with questionnaires before the interviews to facilitate information gathering. Although a written response to the questionnaire is acceptable, DOE prefers an interactive interview process, which helps clarify responses and provides the opportunity to identify additional issues.

[37] This report, titled "Energy Conservation Standards Activities" (Standards Activities), is available on the DOE website at www1.eere.energy.gov/buildings/appliance_standards/2006_schedule_setting.html.

DOE will ask interview participants to identify all confidential information provided in writing or orally. DOE also will determine whether the information submitted is entitled to confidential treatment. DOE will consider the information gathered, as appropriate, in the energy conservation standard decision-making process. DOE will also ask participants to identify any information that they wish to include in the public record, but that they do not want to have associated with their interview (thereby identifying that particular manufacturer). DOE will incorporate this information into the public record, but will report it without attribution.

DOE will collate the interview results and prepare a summary of the major issues and outcomes. This summary will become part of the technical support document for this rulemaking.

12.2 Industry Cash-Flow Analysis

The industry cash-flow analysis will rely primarily on the GRIM. DOE uses the GRIM to analyze the financial impacts of new or more stringent energy conservation standards on the industry that produces the equipment covered by the standard.

The GRIM analysis uses several factors—annual expected revenues; manufacturer costs such as costs of goods sold; selling, general, and administrative costs; taxes; and capital expenditures (both ordinary capital expenditures and those related to standards)—to determine annual cash flows associated with a new standard, beginning from the announcement of the standard and continuing for several years after its implementation. DOE compares the results against base case projections that involve no new standards. The financial impact of new standards is the difference between the two sets of discounted annual cash flows. Other performance measures, such as return on invested capital, are also available from the GRIM.

DOE will gather the inputs needed for the GRIM from two primary sources: the analyses conducted to this point, and interviews with manufacturers and other interested parties. Information gathered from previous analyses will include financial parameters, manufacturing costs, price forecasts, and shipments forecasts. Interviews with manufacturers and other interested parties will be essential in supplementing this information.

12.3 Manufacturer Subgroup Analysis

Using average industry cost values may not adequately assess differential impacts among subgroups of BC or EPS manufacturers. DOE recognizes that smaller, more specialized, or other manufacturers exhibiting a cost structure that differs significantly from the industry average may be affected differently by the imposition of standards. Ideally, DOE would consider the impact on every firm individually. In highly concentrated industries, this may be possible. In industries having numerous participants, however, DOE uses the results of the market and technology assessment to group manufacturers into subgroups, as appropriate. For BCs and EPSs, DOE does not intend to assess the impacts on every manufacturer individually, and therefore is interested in feedback from interested parties about potential subgroups.

The detailed manufacturer subgroup impact analysis will entail calculating cash flows separately for each defined class of manufacturer.

Item 67 *DOE seeks comments on which potential subgroups of BC and EPS manufacturers should consider in its manufacturer subgroup analysis.*

12.4 Competitive Impacts Analysis

EPCA directs DOE to consider any lessening of competition likely to result from an imposition of standards. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It further directs the Attorney General to determine in writing the impacts, if any, of any lessening of competition. (42 U.S.C. 6295(o)(2)(B)(ii))

DOE will make a determined effort to gather firm-specific financial information and impacts, and it will then report the aggregated impact of the standard on manufacturers. The competitive impacts analysis will focus on assessing the impacts on smaller, yet significant, manufacturers. DOE will base the assessment on manufacturing cost data and on information collected from manufacturer interviews. The interviews will focus on gathering information that would help in assessing asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (*e.g.*, proprietary technologies). DOE will provide the Attorney General with a copy of the NOPR for consideration in evaluating the potential competitive impact that standards would have.

12.5 Cumulative Regulatory Burden

Other regulations may apply to the BCs and EPSs covered under this rulemaking, and to other equipment produced by the same manufacturers. Multiple regulations may result in a significant, cumulative regulatory burden on these manufacturers. DOE will analyze and consider the impact on BC and EPS manufacturers of multiple, equipment-specific regulatory actions.

Other regulations that could impact the industry affected by this rulemaking include:

- energy conservation standards for Class A EPSs established by the Energy Independence and Security Act of 2007 (EISA, Public Law 110-140);
- existing and/or proposed State standards for BCs and EPSs; and
- international standards, including upcoming regulation of EPSs and proposed regulation of BCs by Canada, Australia, and the European Union.

Table 12.1 lists the national and international voluntary and regulatory programs for BCs and EPSs, including the voluntary ENERGY STAR specification in the United States and eight regulatory efforts internationally. Most of the regulatory programs are for EPSs only and follow a structure similar to the ENERGY STAR EPS Version 1.1 specification. ENERGY STAR and Canada also address BCs. Appendix F provides a more complete discussion of these programs.

Table 12.1 National and International Voluntary and Regulatory Programs for BCs and EPSs

Country/Region	Program/Institution	BC	EPS
United States	ENERGY STAR for BC and ENERGY STAR Tier I (V1.1) and Tier II (V2.0) for EPS	X	X
Australia and New Zealand	Minimum Energy Performance Standards (MEPS) AS/NZS 4665:2005		X
Canada	C381.1 for EPS and C381.2 for BC	X	X
China	China National Institute of Standardization (CNIS) and China Standard Certification Center (CSC) Standards		X
European Union	Code of Conduct on Efficiency of External Power Supplies, EU Standby Initiative		X
European Union	Eco-design of Energy-using Products (EuP) Initiative, Directive 2005/32/EC		X
European Union (Subset of Member Countries)	Group for Energy Efficient Appliances		X
Israel	SI 4665.2 (AS/NZX 4665.2-2005)		X
Korea	e-Standby Program		X

Item 68 *DOE seeks comments on other existing and pending regulations it should consider in its examination of cumulative regulatory burden.*

13 UTILITY IMPACT ANALYSIS

Like the life-cycle cost subgroup analysis, DOE completes the utility impact analysis during the NOPR stage of this rulemaking. In the utility impact analysis, DOE estimates the effects of energy conservation standards for BCs and EPSs on electricity sales for the electric utility industry. To quantify this impact, DOE plans to use a variant of EIA's NEMS, called NEMS-BT. [38] NEMS is a large, multi-sectoral, partial-equilibrium model of the U.S. energy sector used primarily to prepare the AEO. NEMS-BT is a customized version of NEMS appropriate for the rulemaking analyses conducted by DOE's Office of Building Technologies. NEMS-BT provides the reference case forecast for the United States through 2030 and is available to the public.

The utility impact analysis compares the NEMS-BT model results for the base case and standards cases. Outputs of the utility impact analysis usually parallel results that appear in the latest AEO, with some additions. Typical outputs include forecasts of electricity generation,

[38] For more information on NEMS, please refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2000*, DOE/EIA-0581 (March 2000). EIA approves the use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on EIA assumptions, DOE refers to the model by the name NEMS-BT. ("BT" refers to DOE's Building Technologies Program, under whose aegis this work has been performed.)

sales, price, and avoided capacity. DOE plans to conduct the utility impact analysis as a scenario departing from the latest AEO reference case. In other words, DOE will model the energy savings impacts from energy conservation standards for BCs and EPSs using NEMS-BT to generate forecasts that deviate from the AEO reference case.[39]

Item 69 *DOE seeks input on its plans to use NEMS-BT to conduct the utility impact analysis.*

14 EMPLOYMENT IMPACT ANALYSIS

DOE includes employment impacts among the factors it considers in selecting a proposed efficiency standard. DOE also considers the impact of CSLs on both direct and indirect employment. There is a general presumption[40] against any CSL that would directly cause plant closures or significant loss of domestic employment unless specifically identified expected benefits of the standard would outweigh such adverse effects. (See the Process Rule, 10 CFR Part 430, Subpart C, Appendix A, sections 4(d)(7)(ii) and (vi), and 5(e)(3)(i)(B).)

During the NOPR stage of the BC and EPS rulemakings, DOE will estimate the impacts of standards on employment for equipment manufacturers, relevant service industries, energy suppliers, and the economy in general. DOE's analysis will cover both direct and indirect employment impacts. Direct employment impacts would result if standards led to a change in the number of employees at manufacturing plants and related supply and service firms. Direct impact estimates are covered in the manufacturer impact analysis.

Indirect employment impacts are impacts on the national economy other than in the manufacturing sector being regulated. Indirect impacts may result both from expenditures shifting among goods (the substitution effect) and changes in income that lead to a change in overall expenditure levels (the income effect). DOE defines indirect employment impacts from standards as net jobs eliminated or created in the general economy as a result of increased spending, driven by the increased equipment prices and reduced spending on energy.

DOE will investigate the combined direct and indirect employment impacts in the employment impact analysis using the "Impact of Sector Energy Technologies" (ImSET) model that Pacific Northwest National Laboratory (PNNL) developed for DOE's Office of Planning, Budget, and Analysis. The model estimates the employment and income effects of energy-saving technologies in buildings, industry, and transportation. In comparison with simple economic

[39] Several NEMS-BT models from previous rulemakings can be found on the DOE's Web site at www1.eere.energy.gov/buildings/appliance_standards.

[40] "(B) If the Department determines that a candidate standard level would be the direct cause of plant closures, significant losses in domestic manufacturer employment, or significant losses of capital investment by domestic manufacturers, that standard level will be *presumed* not to be economically justified unless the Department determines that specifically identified expected benefits of the standard would outweigh this and any other expected adverse effects." (Emphasis added, 10 CFR Part 430, Subpart C, Appendix A, section 5(e)(3)(i)(B)).

multiplier approaches, ImSET allows for more complete and automated analysis of the economic impacts of energy-efficiency investments. Although DOE intends to use ImSET for its analysis of employment impacts, it seeks input on other tools and factors it might consider.

> ***Item 70*** *DOE seeks feedback on its planned approach for assessing direct and indirect national employment impacts.*

15 ENVIRONMENTAL ASSESSMENT

DOE will prepare its draft environmental assessment (EA) pursuant to the National Environmental Policy Act and the requirements under 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), to determine the environmental impacts of the amended standards. The intent of the environmental assessment is to provide emissions results estimates and to fulfill requirements to properly quantify and consider the environmental effects of all new Federal rules.

The environmental assessment will focus on the impact of possible energy conservation standards on the significant pollutants and emissions of electricity-generating power plants. Specifically, the environmental assessment for this rulemaking will consider three types of energy-related emissions — oxides of nitrogen (NO_x), mercury (Hg), and carbon dioxide (CO_2). An additional emission, sulfur dioxide (SO_2), was previously considered. However, DOE has determined that due to the presence of national caps on SO_2 emissions as addressed below, any such reduction resulting from an energy conservation standard would not affect the overall level of SO_2 emissions in the United States.

DOE will estimate the reduction in total emissions of carbon dioxide (CO_2) using the NEMS-BT computer model. DOE will calculate a range of estimates for reduction in NO_x emissions and Hg emissions using current power sector emission rates. DOE will conduct each portion of the environmental impact analysis performed under this rulemaking as an incremental policy impact (*i.e.*, an energy conservation standard for BCs and EPSs) of EIA's AEO forecast, applying the same basic set of assumptions used in the latest version of AEO available for use in this analysis. Also, forecasts conducted with NEMS-BT consider the supply-side and demand-side effects on the electric utility industry. Thus, DOE's analysis will account for any factors affecting the type of electricity generation and, in turn, the amount of airborne emissions the utility industry generates.

The NEMS-BT is run similarly to the AEO2008 NEMS, except the energy use is reduced by the amount of energy saved due to the CSLs. DOE obtains the inputs of national energy savings from the NIA spreadsheet model. For the Environmental Assessment, the output is the forecasted physical emissions. The net benefit of the standard is the difference between emissions estimated by NEMS-BT and the AEO2008 Reference Case. The NEMS-BT tracks CO_2 emissions using a detailed module that provides results with a broad coverage of all sectors and inclusion of interactive effects.

Item 71 *DOE seeks input on its plans to use NEMS-BT to conduct the environmental impact analysis on the equipment covered by this rulemaking. DOE is particularly interested in whether there are any other approaches to the environmental assessment that it should consider and the advantages and disadvantages for each of those approaches.*

The Clean Air Act Amendments of 1990 set an emissions cap on SO_2 for all power generation. The attainment of this target, however, is flexible among generators and is enforced through the use of emissions allowances and tradable permits. Because SO_2 emissions allowances have value, they will almost certainly be used by generators, although not necessarily immediately or in the same year regardless of whether a standard is in place. In other words, with or without a standard, total cumulative SO_2 emissions will always be at or near the ceiling, while there may be some timing differences among yearly forecasts. Thus, it is unlikely that there will be an SO_2 environmental benefit from standards as long as there is enforcement of the emissions ceilings. Although there may not be an actual reduction in SO_2 emissions from electricity savings, there still may be an economic benefit from reduced demand for SO_2 emission allowances. Electricity savings decrease the generation of SO_2 emissions from power production, which can decrease the need to purchase or generate SO_2 emissions allowance credits, and decrease the costs of complying with regulatory caps on emissions.

NO_x emissions are currently subject to emissions caps under the Clean Air Interstate Rule (CAIR) published in the Federal Register on May 12, 2005. 70 FR 25162 (May 12, 2005). The CAIR caps emissions in 28 eastern States and the District of Columbia (D.C.). As with the SO_2 emissions cap, energy conservation standards are not likely to have a physical effect on NO_x emissions in those States. However, the standards created by a final rule that may result from this framework document might produce an environmentally related economic impact in the form of lower prices for emissions allowance credits if they were large enough. DOE believes that such standards would not produce such an impact because the estimated reduction in NO_x emissions or the corresponding increase in available allowance credits in States covered by the CAIR cap would be too small to affect allowance prices for $NO_{x.}$

In contrast, new or amended energy conservation standards would reduce NO_x emissions in those 22 States that are not affected by the CAIR, and these emissions could be estimated from NEMS-BT. As a result, DOE will use NEMS-BT to forecast emission reductions from any standards that DOE ultimately proposes in a NOPR for the products covered by this framework document.

Though currently in effect, CAIR has been the subject of significant litigation. CAIR was vacated by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) in its July 11, 2008, decision in *North Carolina v. Environmental Protection Agency*.[41] However, on December 23, 2008, the D.C. Circuit decided to allow the CAIR to remain in effect until it is replaced by a rule consistent with the court's earlier opinion.[42]

[41] 531 F.3d 896 (D.C. Cir. 2008)
[42] *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008) (remand of vacatur).

Similar to SO_2 and NO_x, future emissions of Hg would have been subject to emission caps under the Clean Air Mercury Rule (CAMR). The CAMR would have permanently capped emissions of Hg for new and existing coal-fired plants in all States by 2010, but was vacated by the D.C. Circuit in its February 8, 2008, decision in *New Jersey v. Environmental Protection Agency*.[43] DOE typically uses the NEMS-BT model to calculate emissions from the electrical generation sector; however, the 2008 NEMS-BT model is not suitable for assessing mercury emissions in the absence of a CAMR cap. Thus, DOE plans to use a range of Hg emissions rates (in metric tons of Hg per energy terawatt hour (TWh) produced) based on the AEO2008. To estimate the reduction in mercury emissions, DOE will then multiply the emission rate by the reduction in coal-generated electricity associated with standards considered.

Item 72 *Because court actions have vacated the CAIR, DOE seeks input on how it should address NO_x emissions in this rulemaking.*

Item 73 *Because court actions have vacated the CAMR, DOE seeks input on how it should address Hg emissions in this rulemaking.*

DOE will calculate the possible monetary benefit of CO_2, NO_x, and Hg reductions. Cumulative monetary benefits will be determined using discount rates of 3 and 7 percent. DOE will monetize reductions in CO_2 emissions due to the potential standards based on a range of monetary values drawn from studies that attempt to estimate the present value of the marginal economic benefits (based on the avoided marginal social costs of carbon) likely to result from reducing greenhouse gas emissions. The marginal social cost of carbon is an estimate of the monetary value to society of the environmental damages of CO_2 emissions. This concept will be used rather than compliance costs because CO_2 is not regulated.

SO_2 emissions have markets for emissions allowances. The market clearing price of SO_2 emissions is roughly the marginal cost of meeting the regulatory cap, not the marginal value of the cap itself. Further, because SO_2 (for the nation) is regulated by a cap and trade system, the effect of the need to meet these caps is already included in the price of energy or energy savings. With a cap on SO_2, the value of energy savings already includes the value of SO_2 control for those consumers experiencing energy savings. The economic cost savings associated with SO_2 emissions caps is approximately equal to the change in the price of traded allowances resulting from energy savings multiplied by the number of allowances that would be issued each year. That calculation is uncertain because the energy savings for BCs and EPSs would most likely be so small relative to the entire electricity generation market that the resulting emissions savings would have almost no impact on price formation in the allowances market and likely would be outweighed by uncertainties in the marginal costs of compliance with the SO_2 emissions caps.

[43] *New Jersey v. EPA*, 517 F.3d 574 (D.C. Cir. 2008).

Item 74 *DOE invites comments on how to estimate such monetary values associated with emissions reductions or on any widely accepted values which might be used in DOE's analyses.*

Item 75 *DOE seeks input on other environmental factors to consider in this rulemaking.*

16 REGULATORY IMPACT ANALYSIS

In the NOPR stage of this rulemaking, DOE will prepare a regulatory impact analysis. This analysis will address the potential for non-regulatory approaches to supplant or augment energy conservation standards to improve the efficiency of BCs and EPSs in the market.

The regulatory impact analysis will consider the likely effects of non-regulatory initiatives on BC and EPS energy use, consumer utility, and life-cycle costs. DOE will account for the actual impacts of any existing initiatives to date, and consider historical information that may reasonably estimate the impacts of any such initiative in the future. DOE will use the NES spreadsheet model (section 10.2, "Calculation of National Energy Savings") to calculate the NES and NPV for the alternatives to the potential conservation standards under consideration.

As part of the regulatory impact analysis, and as discussed in section 12, "Manufacturer Impact Analysis," DOE will identify and seek to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same products. This will include the collection of data on potential small manufacturer impacts or competitive disruptions that may result from any regulation. Furthermore, DOE will consider small business impacts on consumers in the life-cycle cost subgroup analysis, section 11.

If DOE proposes energy conservation standards for BCs and EPSs and if the proposed rule constitutes a significant regulatory action, DOE will submit to OMB an assessment of costs and benefits required under section 6(a)(3) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (October 4, 1993). The Executive Order requires agencies to identify the specific market failure or other specific problem they intend to address that warrant new agency action, and also to assess the significance of that problem to help determine whether new regulation is warranted. (Executive Order 12866, section 1(b)(1)) Without a market failure, a regulation cannot result in net benefits. DOE seeks comments on the potential market failures discussed in section 3.1 of this framework document.

Of course, there are likely to be external benefits resulting from the improved efficiency of BCs and EPSs that are not captured by the users of such equipment. These benefits include both environmental and energy security-related effects that are not already reflected in energy prices such as reduced emissions of greenhouse gases and reduced use of natural gas and oil for electricity generation. DOE seeks comments on the weight that it should give to these factors in determining the maximum efficiency level at which the total benefits are likely to exceed the total burdens resulting from a DOE standard.

APPENDIX A – EPCA DIRECTIVES REGARDING BATTERY CHARGERS AND EXTERNAL POWER SUPPLIES

This appendix lists the relevant statutory requirements under 42 U.S.C. 6291, 42 U.S.C. 6293, and 42 U.S.C. 6295 that apply to BCs and EPSs. These requirements are drawn from sections 321, 323, and 325 of EPCA, as amended by section 135 of EPACT 2005 and sections 301, 309, and 310 of EISA.

EPCA 321 (42 U.S.C. 6291)

(32) The term "battery charger" means a device that charges batteries for consumer products, including battery chargers embedded in other consumer products.

[* * * * *]

(36) EXTERNAL POWER SUPPLY-

(A) IN GENERAL- The term "external power supply" means an external power supply circuit that is used to convert household electric current into DC current or lower-voltage AC current to operate a consumer product.

(B) ACTIVE MODE- The term "`active mode"' means the mode of operation when an external power supply is connected to the main electricity supply and the output is connected to a load.

(C) CLASS A EXTERNAL POWER SUPPLY-

(i) IN GENERAL- The term "`class A external power supply"' means a device that--

(I) is designed to convert line voltage AC input into lower voltage AC or DC output;

(II) is able to convert to only 1 AC or DC output voltage at a time;

(III) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load;

(IV) is contained in a separate physical enclosure from the end-use product;

(V) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord, or other wiring; and

(VI) has nameplate output power that is less than or equal to 250 watts.

(ii) EXCLUSIONS- The term "`class A external power supply"' does not include any device that--

(I) requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c); or

(II) powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated.

(D) NO-LOAD MODE- The term ""no-load mode"" means the mode of operation when an external power supply is connected to the main electricity supply and the output is not connected to a load.

[* * * * *]

(52) DETACHABLE BATTERY- The term "`detachable battery"' means a battery that is--

(A) contained in a separate enclosure from the product; and

(B) intended to be removed or disconnected from the product for recharging.

EPCA 323(b) (42 U.S.C. 6293(b))

(17) CLASS A EXTERNAL POWER SUPPLIES- Test procedures for class A external power supplies shall be based on the "Test Method for Calculating the Energy Efficiency of Single-Voltage External AC-DC and AC-AC Power Supplies" published by the Environmental Protection Agency on August 11, 2004, except that the test voltage specified in section 4(d) of that test method shall be only 115 volts, 60 Hz.

EPCA 325 (42 U.S.C. 6295)

(u) Battery charger and external power supply electric energy consumption

(1)(A) Not later than 18 months after August 8, 2005, the Secretary shall, after providing notice and an opportunity for comment, prescribe, by rule, definitions and test procedures for the power use of battery chargers and external power supplies.

(B) In establishing the test procedures under subparagraph (A), the Secretary shall -

(i) consider existing definitions and test procedures used for measuring energy consumption in standby mode and other modes; and

(ii) assess the current and projected future market for battery chargers and external power supplies.

(C) The assessment under subparagraph (B)(ii) shall include –

(i) estimates of the significance of potential energy savings from technical improvements to battery chargers and external power supplies; and

(ii) suggested product classes for energy conservation standards.

(D) Not later than 18 months after August 8, 2005, the Secretary shall hold a scoping workshop to discuss and receive comments on plans for developing energy conservation standards for energy use for battery chargers and external power supplies.

(E) EXTERNAL POWER SUPPLIES AND BATTERY CHARGERS-[44]

(i) ENERGY CONSERVATION STANDARDS-

(I) EXTERNAL POWER SUPPLIES- Not later than 2 years after the date of enactment of this subsection, the Secretary shall issue a final rule that determines whether energy conservation standards

[44] The determination required under 49 U.S.C. 6295(u)(1)(E) is due December 19, 2009, which is two years after the enactment of this provision.

shall be issued for external power supplies or classes of external power supplies.

(II) BATTERY CHARGERS- Not later than July 1, 2011, the Secretary shall issue a final rule that prescribes energy conservation standards for battery chargers or classes of battery chargers or determine that no energy conservation standard is technically feasible and economically justified.

(ii) For each product class, any energy conservation standards issued under clause (i) shall be set at the lowest level of energy use that –

(I) meets the criteria and procedures of subsections (o), (p), (q), (r), (s), and (t) of this section; and

(II) would result in significant overall annual energy savings, considering standby mode and other operating modes.

(2) The Secretary and the Administrator shall collaborate and develop programs (including programs under section 6294a of this title and other voluntary industry agreements or codes of conduct) that are designed to reduce standby mode energy use.

(3) EFFICIENCY STANDARDS FOR CLASS A EXTERNAL POWER SUPPLIES-

(A) IN GENERAL- Subject to subparagraphs (B) through (D), a class A external power supply manufactured on or after the later of July 1, 2008, or the date of enactment of this paragraph shall meet the following standards:

Active Mode	
Nameplate Output	**Required Efficiency (decimal equivalent of a percent-age)**
Less than 1 watt	0.5 times the Nameplate Output
From 1 watt to not more than 51 watts	The sum of 0.09 times the Natural Logarithm of the Nameplate Output and 0.5
Greater than 51 watts	0.85
No-Load Mode	
Nameplate Output	**Maximum Consumption**
No more than 250 watts	0.5 watts

(B) NONCOVERED SUPPLIES- A class A external power supply shall not be subject to subparagraph (A) if the class A external power supply is--

(i) manufactured during the period beginning on July 1, 2008, and ending on June 30, 2015; and

(ii) made available by the manufacturer as a service part or a spare part for an end-use product--

(I) that constitutes the primary load; and

(II) was manufactured before July 1, 2008.

(C) MARKING- Any class A external power supply manufactured on or after the later of July 1, 2008 or the date of enactment of this paragraph shall be clearly and permanently marked in accordance with the External Power Supply International Efficiency Marking Protocol, as referenced in the '"Energy Star Program

Requirements for Single Voltage External AC-DC and AC-AC Power Supplies, version 1.1'" published by the Environmental Protection Agency.

(D) AMENDMENT OF STANDARDS-

(i) FINAL RULE BY JULY 1, 2011-

(I) IN GENERAL- Not later than July 1, 2011, the Secretary shall publish a final rule to determine whether the standards established under subparagraph (A) should be amended.

(II) ADMINISTRATION- The final rule shall--

(aa) contain any amended standards; and

(bb) apply to products manufactured on or after July 1, 2013.

(ii) FINAL RULE BY JULY 1, 2015-

(I) IN GENERAL- Not later than July 1, 2015 the Secretary shall publish a final rule to determine whether the standards then in effect should be amended.

(II) ADMINISTRATION- The final rule shall--

(aa) contain any amended standards; and

(bb) apply to products manufactured on or after July 1, 2017.

(4) END-USE PRODUCTS- An energy conservation standard for external power supplies shall not constitute an energy conservation standard for the separate end-use product to which the external power supplies is [sic] connected.

[* * * * *]

(gg) Standby Mode Energy Use-

(1) DEFINITIONS-

(A) IN GENERAL- Unless the Secretary determines otherwise pursuant to subparagraph (B), in this subsection:

(i) ACTIVE MODE- The term '"active mode'" means the condition in which an energy-using product--

(I) is connected to a main power source;

(II) has been activated; and

(III) provides 1 or more main functions.

(ii) OFF MODE- The term '"off mode'" means the condition in which an energy-using product--

(I) is connected to a main power source; and

(II) is not providing any standby or active mode function.

(iii) STANDBY MODE- The term '"standby mode'" means the condition in which an energy-using product--

(I) is connected to a main power source; and

(II) offers 1 or more of the following user-oriented or protective functions:

(aa) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

(bb) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

(B) AMENDED DEFINITIONS- The Secretary may, by rule, amend the definitions under subparagraph (A), taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission.

(2) TEST PROCEDURES-

(A) IN GENERAL- Test procedures for all covered products shall be amended pursuant to section 323 to include standby mode and off mode energy consumption, taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor for each covered product, unless the Secretary determines that--

(i) the current test procedures for a covered product already fully account for and incorporate the standby mode and off mode energy consumption of the covered product; or

(ii) such an integrated test procedure is technically infeasible for a particular covered product, in which case the Secretary shall prescribe a separate standby mode and off mode energy use test procedure for the covered product, if technically feasible.

(B) DEADLINES- The test procedure amendments required by subparagraph (A) shall be prescribed in a final rule no later than the following dates:

(i) December 31, 2008, for battery chargers and external power supplies.

(ii) March 31, 2009, for clothes dryers, room air conditioners, and fluorescent lamp ballasts.

(iii) June 30, 2009, for residential clothes washers.

(iv) September 30, 2009, for residential furnaces and boilers.

(v) March 31, 2010, for residential water heaters, direct heating equipment, and pool heaters.

(vi) March 31, 2011, for residential dishwashers, ranges and ovens, microwave ovens, and dehumidifiers.

(C) PRIOR PRODUCT STANDARDS- The test procedure amendments adopted pursuant to subparagraph (B) shall not be used to determine compliance with product standards established prior to the adoption of the amended test procedures.

(3) INCORPORATION INTO STANDARD-

(A) IN GENERAL- Subject to subparagraph (B), based on the test procedures required under paragraph (2), any final rule establishing or revising a standard for a covered product, adopted after July 1, 2010, shall incorporate standby mode and off mode energy use into a single amended or new standard, pursuant to subsection (o), if feasible.

(B) SEPARATE STANDARDS- If not feasible, the Secretary shall prescribe within the final rule a separate standard for standby mode and off mode energy consumption, if justified under subsection (o).

(ii) APPLICATION DATE.—Section 327 [42 U.S.C. 6297] applies—

(1) to products for which energy conservation standards are to be established under subsection (l), (u), or (v) of this section beginning on the date on which a final rule is issued by the Secretary, except that any State or local standard prescribed or enacted for the product before the date on which the final rule is issued shall not be preempted until the energy conservation standard established under subsection (l), (u), or (v) of this section for the product takes effect; and

(2) to products for which energy conservation standards are established under subsections (w) through (hh) on August 8, 2005, except that any State or local standard prescribed or enacted before the date of enactment of August 8, 2005 shall not be preempted until the energy conservation standards established under subsections (w) through (gg) take effect.

APPENDIX B – DEFINITIONS

This appendix provides statutory definitions relevant to BCs and EPSs.

"Battery Charger"

42 U.S.C. 6291(32)

(32) The term "battery charger" means a device that charges batteries for consumer products, including battery chargers embedded in other consumer products.

"External Power Supply"

42 U.S.C. 6291(36)(A)

(A) IN GENERAL- The term "external power supply" means an external power supply circuit that is used to convert household electric current into DC current or lower-voltage AC current to operate a consumer product.

"Class A External Power Supply"

42 U.S.C. 6291(36)(C)

(i) IN GENERAL- The term "`class A external power supply'" means a device that--

(I) is designed to convert line voltage AC input into lower voltage AC or DC output;

(II) is able to convert to only 1 AC or DC output voltage at a time;

(III) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load;

(IV) is contained in a separate physical enclosure from the end-use product;

(V) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord, or other wiring; and

(VI) has nameplate output power that is less than or equal to 250 watts.

(ii) EXCLUSIONS- The term "`class A external power supply'" does not include any device that--

(I) requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c); or

(II) powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated.

"Detachable Battery"

42 U.S.C. 6291(52)

The term "`detachable battery'" means a battery that is--

(A) contained in a separate enclosure from the product; and

(B) intended to be removed or disconnected from the product for recharging.

"Consumer Product"

42 U.S.C. 6291(1)

The term "consumer product" means any article (other than an automobile, as defined in section 32901(a)(3) of title 49) of a type—

(A) which in operation consumes, or is designed to consume, energy or, with respect to showerheads, faucets, water closets, and urinals, water; and

(B) which, to any significant extent, is distributed in commerce for personal use or consumption by individuals;

without regard to whether such article of such type is in fact distributed in commerce for personal use or consumption by an individual, except that such term includes fluorescent lamp ballasts, general service fluorescent lamps, incandescent reflector lamps, showerheads, faucets, water closets, and urinals distributed in commerce for personal or commercial use or consumption.

APPENDIX C – TEST PROCEDURES

This appendix provides the DOE test procedures for measuring the energy consumption of BCs and EPSs, as contained in 10 CFR 430, Subpart B, Appendices Y and Z, respectively. These test procedures were published in the *Federal Register* on December 8, 2006 and amended by the standby and off mode final rule on March 27, 2009.

Battery Chargers

1. *Scope:* This appendix covers the test requirements used to measure battery charger energy consumption.

2. *Definitions:* The following definitions are for the purposes of understanding terminology associated with the test method for measuring battery charger energy consumption.[45]

Accumulated nonactive energy is the sum of the energy, in watt-hours, consumed by the battery charger in battery-maintenance mode and standby mode over time periods defined in the test procedure.

Active mode is the condition in which the battery is receiving the main charge, equalizing cells, and performing other one-time or limited-time functions necessary for bringing the battery to the fully charged state.

Battery or *battery pack* is an assembly of one or more rechargeable cells intended to provide electrical energy to a consumer product, and may be in one of the following forms: (a) detachable battery: a battery that is contained in a separate enclosure from the consumer product and is intended to be removed or disconnected from the consumer product for recharging; or (b) integral battery: a battery that is contained within the consumer product and is not removed from the consumer product for charging purposes.

Battery energy is the energy, in watt-hours, delivered by the battery under the specified discharge conditions in the test procedure.

Battery maintenance mode or *maintenance mode* is the mode of operation when the battery charger is connected to the main electricity supply and the battery is fully charged, but is still connected to the charger.

Energy ratio or *nonactive energy ratio* means the ratio of the accumulated nonactive energy divided by the battery energy.

Multi-port charger means a battery charger that is capable of simultaneously charging two or more batteries. These chargers also may have multi-voltage capability, allowing two or more batteries of different voltages to charge simultaneously.

[45] For clarity on any other terminology used in the test method, please refer to IEEE Standard 1515– 2000.

Multi-voltage a la carte charger means a separate battery charger that is individually packaged without batteries, and is able to charge a variety of batteries of different nominal voltages. *Standby mode* or *no-load mode* means the mode of operation when the battery charger is connected to the main electricity supply and the battery is not connected to the charger.

3. *Test Apparatus and General Instructions:* The test apparatus, standard testing conditions, and instructions for testing battery chargers shall conform to the requirements specified in section 4, ‘‘Standard Testing Conditions,’’ of the EPA’s ‘‘Test Methodology for Determining the Energy Performance of Battery Charging Systems,’’ December 2005 Incorporated by reference, see § 430.22). The test voltage specified in section 4.1.1, ‘‘Voltage,’’ shall be 115 volts, 60 Hz. The battery charger should be tested using the full test methodology, which has a test duration of 48 hours. In section 4.3.1, ‘‘Precision Requirements,’’ append this sentence to the end: ‘‘The test equipment must be capable of accounting for crest factor and frequency spectrum in its measurement of the UUT input current.’’

4. *Test Measurement:* (a) Inactive Mode Energy Consumption Measurement. The measurement of the battery charger energy ratio shall conform to the requirements specified in section 5, ‘‘Determining BCS Energy Ratio,’’ of the EPA’s ‘‘Test Methodology for Determining the Energy Performance of Battery Charging Systems, December 2005’’ (Incorporated by reference, see § 430.22).

(b) Active Mode Energy Consumption Measurement. [RESERVED]

External Power Supplies

1. *Scope:* This appendix covers the test requirements used to measure the active mode efficiency and the no-load energy consumption of external power supplies.

2. *Definitions:* The following definitions are for the purposes of understanding terminology associated with the test method for measuring external power supply energy consumption.[1]

Active mode is the mode of operation when the external power supply is connected to the main electricity supply and the output is connected to a load.

Active mode efficiency is the ratio, expressed as a percentage, of the total real output power produced by a power supply to the real input power required to produce it.

No load mode means the mode of operation when the external power supply is connected to the main electricity supply and the output is not connected to a load.

Single voltage external AC–AC power supply means an external power supply that is designed to convert line voltage AC input into lower voltage AC output and is able to convert to only one AC output voltage at a time.

Single voltage external AC–DC power supply means an external power supply that is designed to convert line voltage AC input into lower voltage DC output and is able to convert to only one DC output voltage at a time.

Total harmonic distortion, expressed as a percent, is the RMS value of an AC signal after the fundamental component is removed and interharmonic components are ignored, divided by the RMS value of the fundamental component.

True power factor is the ratio of the active (also referred to as real) power consumed in watts to the apparent power, drawn in volt-amperes.

3. *Test Apparatus and General Instructions:* The test apparatus, standard testing conditions, and instructions for testing external power supplies shall conform to the requirements specified in section 4, ''General Conditions for Measurement,'' of the CEC's ''Test Method for Calculating the Energy Efficiency of Single-Voltage External AC–DC and AC–AC Power Supplies,'' August 11, 2004. The test voltage specified in section 4.d, ''Test Voltage,'' shall only be 115 volts, 60 Hz.

4. *Test Measurement:* The measurement of the external power supply active mode efficiency and no-load energy consumption shall conform to the requirements specified in section 5, ''Measurement Approach,'' of the CEC's ''Test Method for Calculating the Energy Efficiency of Single-Voltage External AD–DC and AC–AC Power Supplies,'' August 11, 2004 (Incorporated by reference, see § 430.22).

APPENDIX D – ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

On December 19, 2007, the President signed into law the Energy Independence and Security Act of 2007 (EISA 2007) (P.L. 110-140). This legislation amended certain aspects of EPCA, including, in particular, the potential amendment of existing testing requirements for BCs and EPSs (section 310 of EISA) and addition of mandatory efficiency standards for external power supplies (section 301 of EISA).

SEC. 301. EXTERNAL POWER SUPPLY EFFICIENCY STANDARDS.

(a) Definitions- Section 321 of the Energy Policy and Conservation Act (42 U.S.C. 6291) is amended--

(1) in paragraph (36)--

(A) by striking ”(36) The” and inserting the following:

“(36) EXTERNAL POWER SUPPLY-

“(A) IN GENERAL- The”; and

(B) by adding at the end the following:

“(B) ACTIVE MODE- The term `active mode' means the mode of operation when an external power supply is connected to the main electricity supply and the output is connected to a load.

“(C) CLASS A EXTERNAL POWER SUPPLY-

“(i) IN GENERAL- The term `class A external power supply' means a device that--

“(I) is designed to convert line voltage AC input into lower voltage AC or DC output;

”(II) is able to convert to only 1 AC or DC output voltage at a time;

”(III) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load;

”(IV) is contained in a separate physical enclosure from the end-use product;

”(V) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord, or other wiring; and

”(VI) has nameplate output power that is less than or equal to 250 watts.

“(ii) EXCLUSIONS- The term `class A external power supply' does not include any device that--

“(I) requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c); or

“(II) powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated.

“(D) NO-LOAD MODE- The term `no-load mode' means the mode of operation when an external power supply is connected to the main electricity supply and the output is not connected to a load.”; and

(2) by adding at the end the following:

”(52) DETACHABLE BATTERY- The term `detachable battery' means a battery that is--

”(A) contained in a separate enclosure from the product; and

”(B) intended to be removed or disconnected from the product for recharging.”.

(b) Test Procedures- Section 323(b) of the Energy Policy and Conservation Act (42 U.S.C. 6293(b)) is amended by adding at the end the following:

”(17) CLASS A EXTERNAL POWER SUPPLIES- Test procedures for class A external power supplies shall be based on the `Test Method for Calculating the Energy Efficiency of Single-Voltage External AC-DC and AC-AC Power Supplies' published by the Environmental Protection Agency on August 11, 2004, except that the test voltage specified in section 4(d) of that test method shall be only 115 volts, 60 Hz.”.

(c) Efficiency Standards for Class A External Power Supplies- Section 325(u) of the Energy Policy and Conservation Act (42 U.S.C. 6295(u)) is amended by adding at the end the following:

”(6) EFFICIENCY STANDARDS FOR CLASS A EXTERNAL POWER SUPPLIES-

”(A) IN GENERAL- Subject to subparagraphs (B) through (D), a class A external power supply manufactured on or after the later of July 1, 2008, or the date of enactment of this paragraph shall meet the following standards:

“Active Mode	
“Nameplate Output	**Required Efficiency (decimal equivalent of a percent-age)**
Less than 1 watt	0.5 times the Nameplate Output
From 1 watt to not more than 51 watts	The sum of 0.09 times the Natural Logarithm of the Nameplate Output and 0.5
Greater than 51 watts	0.85
“No-Load Mode	
“Nameplate Output	**Maximum Consumption**
No more than 250 watts	0.5 watts

”(B) NONCOVERED SUPPLIES- A class A external power supply shall not be subject to subparagraph (A) if the class A external power supply is--

”(i) manufactured during the period beginning on July 1, 2008, and ending on June 30, 2015; and

”(ii) made available by the manufacturer as a service part or a spare part for an end-use product--

”(I) that constitutes the primary load; and

“(II) was manufactured before July 1, 2008.

”(C) MARKING- Any class A external power supply manufactured on or after the later of July 1, 2008 or the date of enactment of this paragraph shall be clearly and permanently marked in accordance with the External Power Supply International Efficiency Marking Protocol, as referenced in the `Energy Star Program Requirements for Single Voltage External AC-DC and AC-AC Power Supplies, version 1.1' published by the Environmental Protection Agency.

”(D) AMENDMENT OF STANDARDS-

”(i) FINAL RULE BY JULY 1, 2011-

”(I) IN GENERAL- Not later than July 1, 2011, the Secretary shall publish a final rule to determine whether the standards established under subparagraph (A) should be amended.

”(II) ADMINISTRATION- The final rule shall--

”(aa) contain any amended standards; and "(bb) apply to products manufactured on or after July 1, 2013.

"(ii) FINAL RULE BY JULY 1, 2015-

"(I) IN GENERAL- Not later than July 1, 2015 the Secretary shall publish a final rule to determine whether the standards then in effect should be amended.

"(II) ADMINISTRATION- The final rule shall--

"(aa) contain any amended standards; and

"(bb) apply to products manufactured on or after July 1, 2017.

"(7) END-USE PRODUCTS- An energy conservation standard for external power supplies shall not constitute an energy conservation standard for the separate end-use product to which the external power supplies is connected.".

SEC. 309. BATTERY CHARGERS.

Section 325(u)(1)(E) of the Energy Policy and Conservation Act (42 U.S.C. 6295(u)(1)(E)) is amended--

(1) by striking "(E)(i) Not" and inserting the following:

"(E) EXTERNAL POWER SUPPLIES AND BATTERY CHARGERS-

"(i) ENERGY CONSERVATION STANDARDS-

"(I) EXTERNAL POWER SUPPLIES- Not";

(2) by striking "3 years" and inserting "2 years";

(3) by striking "battery chargers and" each place it appears; and

(4) by adding at the end the following:

"(II) BATTERY CHARGERS- Not later than July 1, 2011, the Secretary shall issue a final rule that prescribes energy conservation standards for battery chargers or classes of battery chargers or determine that no energy conservation standard is technically feasible and economically justified.".

SEC. 310. STANDBY MODE.

Section 325 of the Energy Policy and Conservation Act (42 U.S.C. 6295) is amended—

(1) in subsection (u)—

(A) by striking paragraphs (2), (3), and (4); and

(B) by redesignating paragraphs (5) and (6) as paragraphs (2) and (3), respectively;

(2) by redesignating subsection (gg) as subsection (hh);

(3) by inserting after subsection (ff) the following:

”(gg) Standby Mode Energy Use-

”(1) DEFINITIONS-

”(A) IN GENERAL- Unless the Secretary determines otherwise pursuant to subparagraph (B), in this subsection:

”(i) ACTIVE MODE- The term `active mode' means the condition in which an energy-using product—

”(I) is connected to a main power source;

”(II) has been activated; and

”(III) provides 1 or more main functions.

”(ii) OFF MODE- The term `off mode' means the condition in which an energy-using product—

”(I) is connected to a main power source; and

”(II) is not providing any standby or active mode function.

”(iii) STANDBY MODE- The term `standby mode' means the condition in which an energy-using product—

”(I) is connected to a main power source; and

”(II) offers 1 or more of the following user-oriented or protective functions:

”(aa) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

”(bb) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

”(B) AMENDED DEFINITIONS- The Secretary may, by rule, amend the definitions under subparagraph (A), taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission.

”(2) TEST PROCEDURES-

”(A) IN GENERAL- Test procedures for all covered products shall be amended pursuant to section 323 to include standby mode and off mode energy consumption, taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor for each covered product, unless the Secretary determines that—

”(i) the current test procedures for a covered product already fully account for and incorporate the standby mode and off mode energy consumption of the covered product; or

”(ii) such an integrated test procedure is technically infeasible for a particular covered product, in which case the Secretary shall prescribe a separate standby mode and off mode energy use test procedure for the covered product, if technically feasible.

”(B) DEADLINES- The test procedure amendments required by subparagraph (A) shall be prescribed in a final rule no later than the following dates:

”(i) December 31, 2008, for battery chargers and external power supplies.

”(ii) March 31, 2009, for clothes dryers, room air conditioners, and fluorescent lamp ballasts.

”(iii) June 30, 2009, for residential clothes washers.

”(iv) September 30, 2009, for residential furnaces and boilers.

”(v) March 31, 2010, for residential water heaters, direct heating equipment, and pool heaters.

”(vi) March 31, 2011, for residential dishwashers, ranges and ovens, microwave ovens, and dehumidifiers.

”(C) PRIOR PRODUCT STANDARDS- The test procedure amendments adopted pursuant to subparagraph (B) shall not be used to determine compliance with product standards established prior to the adoption of the amended test procedures.

”(3) INCORPORATION INTO STANDARD-

”(A) IN GENERAL- Subject to subparagraph (B), based on the test procedures required under paragraph (2), any final rule establishing or revising a standard for a covered product, adopted after July 1, 2010, shall incorporate standby mode and off mode energy use into a single amended or new standard, pursuant to subsection (o), if feasible.

”(B) SEPARATE STANDARDS- If not feasible, the Secretary shall prescribe within the final rule a separate standard for standby mode and off mode energy consumption, if justified under subsection (o).”; and

(4) in paragraph (2) of subsection (hh) (as redesignated by paragraph (2)), by striking ”(ff)” each place it appears and inserting ”(gg)”.

APPENDIX E – LIST OF ITEMS FOR COMMENT

This appendix lists all the items for comments contained in this framework document and the page numbers on which those items can be found.

Item 1 DOE invites interested parties to review the draft technical report published in conjunction with this framework document and to provide comments on the analytical structure, inputs, and method DOE followed.. 11
Item 2 DOE welcomes comment from interested parties on differentiating between wall adapters and cradles. DOE also seeks comment on the type of circuitry (or lack thereof) typically contained in cradles.. 14
Item 3 DOE requests comment from interested parties on its interpretation of the Class A EPS exclusion of medical EPSs. 17
Item 4 DOE seeks comments on including DC-powered battery chargers within the scope of the BC standards analysis. 18
Item 5 DOE welcomes comment on any products with detachable batteries that are not motor operated, the wall adapters of which should also be excluded from Class A EPS standards. 22
Item 6 DOE requests comment on its interpretation of the definition of "detachable battery," and the impact on EPSs excluded from Class A. 22
Item 7 DOE welcomes comment on ways of amending Approach B to make it consistent with the statutory language in EISA, or proposals of alternate approaches based on the clear BC and EPS divisions of the ENERGY STAR program. 32
Item 8 DOE seeks comment on the prevalence of wall adapters for battery charging applications that may not be testable under the EPS test procedure.. 37
Item 9 DOE seeks comments on the four approaches to interpreting the BC and EPS definitions to resolve ambiguities in the scope of the analyses. DOE is also interested in determining whether Approach B could be modified to permit its use in a manner consistent with the statutory framework created by Congress... 38
Item 10 DOE welcomes comment on additional functionality provided by some wall adapters for battery chargers that may impede their ability to meet the same standards as comparable wall adapters for other applications. DOE asks that commenters provide specific examples and suggest ways in which DOE can address any potential barriers that may arise. 38
Item 11 DOE welcomes comment on the manufacturer burden of compliance with current EISA Class A EPS standards under each of the four approaches and seeks information on how DOE can minimize this burden while ensuring that the standards are being met consistently by the industry... 38
Item 12 DOE also welcomes comment on the likely manufacturer burden of compliance with possible future EPS and BC standards under each of the four approaches. To this end, DOE also seeks information from the industry regarding how the monitoring of compliance with these standards can be accomplished. 38
Item 13 DOE is seeking input on these and any additional criteria it should consider in determining the presence of wall adapter charge control functions. 39

Item 14 DOE welcomes comment on external characteristics (either physical or electrical) that can be used to identify a wall adapter performing charge control for determining compliance with the appropriate standard under Approaches A, C, and D, as well as the use of labeling to permit easy identification. How likely would it be that those requirements would be subject to potential manipulation by manufacturers? If manipulation is possible, what form, and in what context, would these activities likely occur? 39
Item 15 DOE welcomes comment on the possible differences in distribution channels between wall adapters used for battery charging applications that do and do not have charge control functions. 41
Item 16 DOE seeks comments on whether these and/or other factors influence the shipments of BCs and EPSs, and the extent to which each trend is likely to affect shipments. 42
Item 17 DOE seeks input on shipment data for BCs and EPSs and the applications that use them, including applications that use non-Class A EPSs (section 3.6.2). DOE also seeks input on the percentage of applications that are shipped with either a BC or an EPS. 43
Item 18 DOE invites interested parties to review and comment on domestic and foreign efficiency programs relating to BCs and EPSs. 44
Item 19 DOE seeks comments and data from interested parties on these and other potential market failures that may apply to BCs and EPSs. 44
Item 20 DOE seeks comments on whether the 0.2 C charge-rate division between slow and fast chargers is appropriate and seeks detailed information regarding the typical charge rates for both categories of BCs. 47
Item 21 Although DOE intends to revisit this issue in the future, its test procedure does not currently measure active-mode energy consumption. Nonetheless, DOE seeks comments on how it can best account for energy consumed during active mode. 50
Item 22 DOE seeks comments on how DOE could, in a future rulemaking, amend its BC test procedure to measure energy consumption in active mode. 50
Item 23 DOE seeks comments on BC product class divisions, including whether battery voltage is the appropriate product classification criterion, and/or whether DOE should take into account other factors, such as charge rate, battery capacity, or battery chemistry. 52
Item 24 DOE seeks comments on creating potential product class divisions for EPSs excluded from the EISA definition of Class A. 53
Item 25 DOE seeks comments on whether to consider the presence of ICs or PFC circuitry in developing product classes for EPSs. 56
Item 26 DOE seeks comments on how to consider output voltage in developing product classes, and how the low-voltage division should vary with EPS output power. 56
Item 27 DOE seeks comments on the possible approaches discussed concerning EPS product classes, and invites interested parties to propose alternative approaches and/or other factors DOE should consider in developing product classes for the preliminary analyses. 56
Item 28 DOE seeks comments on how the product classes it is considering for Class A EPSs may apply to non-Class A EPSs and whether there are particular issues DOE needs to take into account. 57
Item 29 DOE seeks comments on all aspects of the product classes it is considering for BCs and EPSs, as well as any other methods for establishing product classes in accordance with the requirements of 42 U.S.C. 6295(q). 57

Item 30 DOE seeks comments on the preliminary technology options identified in this section and whether there are other technology options it should consider. In commenting on design options, please discuss their impacts, if any, on safety, performance, and consumer utility........ 59
Item 31 DOE seeks comments on how the four screening criteria might apply to the technology options discussed in section 3.7, as well as any additional technology option(s) that an interested party recommends to DOE. 60
Item 32 DOE seeks comments on any consumer product applications which require use of a line-frequency EPS, and which could not accommodate use of a switched-mode EPS.............. 61
Item 33 DOE seeks recommendations on possible candidate standard levels to use when analyzing EPSs and BCs.. 63
Item 34 DOE invites comments on the identification and selection of representative product classes and on models that may serve as good representative units within each product class. DOE also seeks comments on appropriate scaling relationships among product classes for both BCs and EPSs. 64
Item 35 DOE seeks comments on representative product classes and selection of representative units from those representative product classes. 65
Item 36 DOE seeks comments on the scaling of findings from representative product classes to other product classes that DOE may not explicitly analyze. 65
Item 37 DOE invites manufacturers to work with DOE in the interviews to help develop aggregated curves of manufacturer selling price versus efficiency for the various representative units. 66
Item 38 DOE seeks comments on methods for normalizing cost and efficiency data provided by manufacturers for EPSs with output power and output voltage that differ from those of the representative units. 66
Item 39 DOE seeks comments on the shipment volumes to use for the representative units.. 66
Item 40 DOE seeks comments on this and other possible methods of determining and validating manufacturing costs. DOE is particularly interested in obtaining high-volume component costs and typical manufacturer markups applied to the bill-of-materials cost........... 67
Item 41 DOE welcomes comment on methods for simulating the performance of highly-efficient EPSs and BCs as a means of validating data provided by manufacturers..................... 67
Item 42 Are there proprietary designs of which DOE should be aware for any of the BCs and EPSs under consideration in this rulemaking? If so, how should DOE acquire the cost data necessary for evaluating these designs?... 68
Item 43 DOE seeks comments on regulatory burdens or changes that should be considered in the engineering analysis of BCs and EPSs. 68
Item 44 DOE seeks comments on any other issues that could affect the engineering analysis. 68
Item 45 DOE seeks comments on the consumer usage profiles presented in sections 6.2.1 and 6.3.1 of the draft technical report. DOE seeks alternate sources, databases, or methodologies for developing usage profiles. DOE also seeks comments on its assumption that the usage profiles do not vary over the analysis period. 69
Item 46 DOE requests comments on the use of 24-hour charge cycles for estimating energy consumption for BCs in active mode.. 70
Item 47 DOE requests comments on the methodology presented for calculating unit energy consumption. DOE also requests comments on the usage profiles detailed in section 6.2 of the draft technical report.. 71

Item 48 DOE requests comments on the usage profiles for EPS applications detailed in section 6.3 of the draft technical report. 73
Item 49 DOE requests comment on its proposed methodology for calculating energy consumption at each application state under EPS active mode. 77
Item 50 DOE requests comments on its proposed methodology for calculating energy consumption at output levels below 25 percent of nameplate output power. 77
Item 51 DOE requests comments on its proposal to associate off mode with unplugged mode for the purposes of calculating energy consumption. DOE also requests comments on time spent in off mode, as well as power consumption while in off mode. 78
Item 52 DOE seeks comments on all aspects of the product price determination for BCs and EPSs, including assumptions about the percent of shipments passing through each distribution channel and the markups associated with each channel. 80
Item 53 DOE seeks comments on its intention to focus its preliminary LCC analysis on the residential sector, and not the commercial or industrial sectors. 82
Item 54 DOE seeks comments on the use of the EIA national average electricity price and the AEO forecast of electricity prices over the analysis period. 86
Item 55 DOE seeks comments on the methodology to be used for calculating residential discount rate used in the LCC analysis. 87
Item 56 DOE seeks comments on appropriate lifetimes for the BCs and EPSs covered in this rulemaking. 88
Item 57 DOE seeks input on additional sources for the lifetimes of BCs and EPSs and comments on the application lifetimes provided in section 8.3.5 of the draft technical report. ... 89
Item 58 DOE seeks recommendations on sources of data on shipments of BCs and EPSs by product group. 90
Item 59 DOE seeks recommendations on sources of data that would provide accurate and up-to-date information on BC and EPS efficiency distributions within product groups. DOE also seeks comments on how it might characterize long-term trends in the efficiency of BCs and EPSs for its base case shipments forecasts. 91
Item 60 DOE seeks comments on appropriate shipment growth rates. 92
Item 61 DOE seeks input on the sensitivity of BC and EPS demand to changes in price. 93
Item 62 DOE seeks comments on how any new energy conservation standard for BCs and EPSs might affect shipments of these products. DOE specifically seeks comments on its rollup and shift scenarios, as discussed in section 9.3 of the draft technical report. 93
Item 63 DOE seeks comments on the impact of the rebound effect, the associated application effect, and the consumer awareness effect on energy consumption of BCs and EPSs. To the extent that commenters can offer reasons and data supporting the adoption of a particular quantitative value for each of these effects, DOE is also interested in this information. 94
Item 64 DOE requests comments on the percent distribution of residential and commercial energy use for calculation of the weighted-average energy price. 96
Item 65 DOE seeks comments on the NES/NPV spreadsheet models that DOE plans to use for estimating national impacts of energy conservation standards for BCs and EPSs. See chapter 10 of the draft technical report for a description of these models. 97
Item 66 DOE seeks comments on which consumer subgroups, if any, DOE should consider when developing standards for BCs and EPSs. 97
Item 67 DOE seeks comments on which potential subgroups of BC and EPS manufacturers should consider in its manufacturer subgroup analysis. 100

Item 68 DOE seeks comments on other existing and pending regulations it should consider in its examination of cumulative regulatory burden. 101
Item 69 DOE seeks input on its plans to use NEMS-BT to conduct the utility impact analysis. 102
Item 70 DOE seeks feedback on its planned approach for assessing direct and indirect national employment impacts. 103
Item 71 DOE seeks input on its plans to use NEMS-BT to conduct the environmental impact analysis on the equipment covered by this rulemaking. DOE is particularly interested in whether there are any other approaches to the environmental assessment that it should consider and the advantages and disadvantages for each of those approaches. 104
Item 72 Because court actions have vacated the CAIR, DOE seeks input on how it should address NO_x emissions in this rulemaking. 105
Item 73 Because court actions have vacated the CAMR, DOE seeks input on how it should address Hg emissions in this rulemaking. 105
Item 74 DOE invites comments on how to estimate such monetary values associated with emissions reductions or on any widely accepted values which might be used in DOE's analyses. 106
Item 75 DOE seeks input on other environmental factors to consider in this rulemaking. ... 106

APPENDIX F – OTHER MANDATORY AND VOLUNTARY ENERGY-EFFICIENCY STANDARDS FOR BCEPS

F.1 United States – ENERGY STAR for BC and ENERGY STAR Tier I (V1.1) and Tier II (V2.0) for EPS

Revised U.S. ENERGY STAR levels became effective on November 1, 2008. These voluntary levels are stricter than V1.1 levels, and provide separate levels for standard vs. low-voltage models and for AC/AC versus AC/DC models.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 250 watts, and battery chargers for heat, light, and motion products with a 42-V limit and a 2-watt to 300-watt input limit. Notable exclusions to V1.1 are devices with detachable batteries, motor-operated devices, and medical devices. Notable exclusions to V2.0 are devices with batteries that attach directly. Exclusions to battery charger standards are inductive chargers and systems with additional functions.

F.1.1 Current Standards

- Version: Tier II v2.0 for EPS
- Compliance: Voluntary
- Effective: November 1, 2008

Table F.1. U.S. ENERGY STAR Tier II for EPS Active-Mode Efficiency and No-Load Power: Standard Models

Nameplate Output Power	Minimum Efficiency in Active Mode
$0 < W \leq 1$	0.480 * Nameplate Output + 0.140
$1 < W \leq 49$	0.0626 * Ln(Nameplate Output) + 0.622
$49 < W$	0.870

Nameplate Output Power	Maximum No-Load Power Consumption AC/AC	Maximum No-Load Power Consumption AC/DC
$0 < W < 50$	$\leq$ 0.50 W	$\leq$ 0.30 W
$50 \leq W \leq 250$		$\leq$ 0.50 W

Table F.2. U.S. ENERGY STAR Tier II for EPS Active-Mode Efficiency and No-Load Power: Low-Voltage Models

Nameplate Output Power	Minimum Efficiency in Active Mode (Less than 6 Volts)
0 < W ≤ 1	0.497 * Nameplate Output + 0.067
1 < W ≤ 49	0.0750 * Ln(Nameplate Output) + 0.561
49 < W	0.86

Nameplate Output Power	Maximum No-Load Power Consumption AC/AC	Maximum No-Load Power Consumption AC/DC
0 < W < 50	≤ 0.50 W	≤ 0.30 W
50 ≤ W ≤ 250		≤ 0.50 W

- Version: ENERGY STAR for BC
- Compliance: Voluntary
- Effective: January 1, 2006

Table F.3. ENERGY STAR Specifications for BC Maximum Nonactive Energy Ratio

Nominal Battery Voltage	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
Maximum Nonactive Energy Ratio	20.0	16.9	13.7	11.6	9.6	7.5	7.0	6.5	6.1	5.6
Nominal Battery Voltage	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	≥ 24
Maximum Nonactive Energy Ratio	5.1	4.5	4.3	4.2	3.8	3.6	3.5	3.3	3.2	3.0

*Energy Ratio is a function of maintenance mode power and no-load power.

F.2 Australia and New Zealand – Minimum Energy Performance Standards (MEPS) AS/NZS 4665:2005

Administered by the Australian Greenhouse Office (AGO) through the National Appliance and Equipment Energy Efficiency Committee (NAEEEC), the Australian MEPS are mandatory. Voluntary higher efficiency levels exist, which will become the new MEPS in the future.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 250 watts. Notable exclusions are devices with batteries that attach directly, replacements, and medical devices. No-load power requirements only apply to AC/DC power supplies.

The MEPS program does not yet deal with battery chargers, but if future standards were introduced, they would likely use the ENERGY STAR test method and MEPS, applying at 230 Vac only. If specific MEPS are not introduced for battery chargers, the 1-watt standby proposal will apply.

F.2.1 Current Standards

- Version: MEPS for EPS
- Compliance: Mandatory MEPS (Mark III), Voluntary High Efficiency (Mark IV and Mark V)
- Effective: Australia - December 1, 2008, New Zealand – April 1, 2009

Table F.4. Australia/New Zealand MEPS Levels for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
$0 < W \leq 1$	0.49 * Nameplate Output
$1 < W \leq 49$	0.09 * Ln(Nameplate Output) + 0.49
$49 < W \leq 250$	0.84
Nameplate Output Power	**Maximum No-Load Power Consumption**
$0 < W < 10$	≤ 0.50 W
$10 \leq W \leq 250$	≤ 0.75 W

Table F.5. Australia/New Zealand High Efficiency Level IV for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W ≤ 1	0.5 * Nameplate Output
1 < W ≤ 51	0.09 * Ln(Nameplate Output) + 0.5
51 < W ≤ 250	0.85
Nameplate Output Power	**Maximum No-Load Power Consumption**
0 < W ≤ 250	≤ 0.50 W

Table F.6. Australia/New Zealand High Efficiency Level V for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode – Less than 6 Volts	Minimum Efficiency in Active Mode – Greater than 6 Volts
0 < W ≤ 1	0.497 * Nameplate Output + 0.067	0.480 * Nameplate Output + 0.140
1 < W ≤ 51	0.0750 * Ln(Nameplate Output) + 0.561	0.0626 * Ln(N ameplate Output) + 0.622
51 < W ≤ 250	0.86	0.87

Nameplate Output Power	Maximum No-Load Power Consumption AC/AC	Maximum No-Load Power Consumption AC/DC – Less than 6 Volts	Maximum No-Load Power Consumption AC/DC – Greater than 6 Volts
0 < W ≤ 51	≤ 0.50 W	≤ 0.30 W	≤ 0.30 W
51 < W ≤ 250		≤ 0.50 W	No Maximum

F.3 Canada – C381.1 for EPS and C381.2 for BC

The Canadian Standards Association (CSA) is developing standards for external power supplies and battery chargers that are expected to become mandatory, which will require approval from Natural Resources Canada after the CSA has finalized the standards.

The proposed specifications for EPSs follow EISA levels, and scope. The specifications for BCs will likely follow CEC test procedures, levels, and scope.

F.3.1 Current Standards

- Version: Minimum Energy Performance Standards for EPSs
- Compliance: Mandatory
- Effective: Proposed September 1, 2009 for EPSs; awaiting comment from stakeholders. 2010 for BCs.

Nameplate Output Power	Minimum Efficiency in Active Mode
$0 < W \leq 1$	0.5 * Nameplate Output
$1 < W \leq 51$	0.09 * Ln(Nameplate Output) + 0.5
$51 < W \leq 250$	0.85

Nameplate Output Power	Maximum No-Load Power Consumption
$0 < W \leq 250$	$\leq$ 0.50 W

F.4 China – China National Institute of Standardization (CNIS) and China Standard Certification Center (CSC) Standards

Designed and administered by the China National Institute of Standardization (CNIS) and the China Standard Certification Center (CSC), Chinese standards for external power supplies include both mandatory minimum efficiency levels and voluntary high-efficiency levels.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 250 watts. Notable exclusions to the CSC standards are devices with batteries that attach directly. Battery charger standards do not exist but plans to draft them are in place, with consideration of modes beyond no-load mode.

F.4.1 Current Standards

- Version: CNIS levels
- Compliance: Mandatory
- Effective: Possibly 2009

Table F.7. CNIS MEPS for Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W ≤ 1	0.39 * Nameplate Output
1 < W ≤ 49	0.107 * Ln(Nameplate Output) + 0.39
49 < W ≤ 250	0.82

Nameplate Output Power	Maximum No-Load Power Consumption
0 < W < 10	≤ 0.75 W
10 ≤ W ≤ 250	≤ 1 W

- Version: CSC levels
- Compliance: Voluntary
- Effective: May 2005

Table F.8. CSC Levels for Active-Mode Efficiency and No-Load Power (Same as ENERGY STAR Tier 1)

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W < 1	0.49 * Nameplate Output
1 ≤ W ≤ 49	0.09 * Ln(Nameplate Output) + 0.49
49 < W ≤ 250	0.84

Nameplate Output Power	Maximum No-Load Power Consumption
0 < W < 10	≤ 0.50 W
10 ≤ W ≤ 250	≤ 0.75 W

F.5 European Union—Code of Conduct on Efficiency of External Power Supplies, EU Standby Initiative

Developed and administered by the European Commission Joint Research Centre, the EU Code of Conduct is a voluntary agreement. Signatories to the Code of Conduct, which include major manufacturers of external power supplies, agree to meet active-mode efficiency and no-load power consumption targets for at least 90 percent of their product lines.

Power converters covered under this standard include all single-voltage EPSs and battery charger wall adapters with nameplate output power in the range 0.3 watts to 150 watts. The scope of the standard will be expanded in 2009 to include external power supplies with nameplate output power up to 250 watts. Version 3 of the Code of Conduct includes a separate product class for cellular telephone EPSs, which is subject to different standards.

F.5.1 Current Standards

- Version: 2
- Compliance: Voluntary
- Effective: January 1, 2007

Table F.9. EU Code of Conduct Version 2 Standards for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode*
0 to < 1 W	0.49 * Nameplate Output
≥ 1 and ≤ 49 W	0.09 * Ln(Nameplate Output) + 0.49
> 49 W to 150 W	0.84
Nameplate Output Power	**Maximum No-Load Power Consumption**
≥ 0.3 W and < 60 W	0.30 W
≥ 60 W and < 150 W	0.50 W

* Power supplies that have a power factor correction (PFC) to comply with EN61000-3-2 (above 75 W input power) have a 0.04 (4-percent) allowance. Therefore, the minimum on mode-load efficiency (100 percent or averaged) is relaxed to 0.80 (80 percent).

F.5.2 Future Standards

- Version: 3
- Compliance: Voluntary
- Effective: January 1, 2009

Table F.10. EU Code of Conduct Version 3 Standards for EPSs Excluding Cellular Telephone Adapters with Nameplate Output Power ≤ 8 Watts

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W ≤ 1	0.44 * Pno + 0.145
1 < W ≤ 36	[0.08 * ln(Pno)] + 0.585
36 < W ≤ 250	0.870
Nameplate Output Power	**Maximum No-Load Power Consumption**
> 0.3 W and < 50 W	0.30 W
> 50 W and < 250 W	0.50 W

Table F.11. EU Code of Conduct Version 3 Standards for Cellular Telephone Adapters with Nameplate Output Power ≤ 8 Watts

Nameplate Output Power	Minimum Efficiency in Active Mode
> 0 W and < 1 W	0.50*Pno+0.029
> 1 W and < 8 W	[0.095*ln(Pno)]+0.529
Nameplate Output Power	**Maximum No-Load Power Consumption**
> 0.3 W and < 8.0 W	0.25 W from 1.1.2009 to 31.12.2010
> 0.3 W and < 8.0 W	0.15 W from 1.1.2011

F.6 European Union—Eco-design of Energy-using Products (EuP) Initiative, Directive 2005/32/EC

Developed and administered by the European Commission, the Eco-design of EuP Initiative is a mandatory directive. When complete, the directive will provide EU-wide rules for eco-design so that differences in national regulations do not present barriers to intra-EU trade. Minimum energy-efficiency requirements are among the product characteristics being addressed, including MEPS for external power supplies.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 250 watts. Though battery chargers are not addressed, there are tentative plans for BC standards of 1 watt in off mode, enforced in 2009, dropping to 0.5 watt by 2011.

F.6.1 Current Standards

- Version: 1
- Compliance: Mandatory
- Effective: April 26, 2010

Table F.12. EuP Version 1 Levels for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W < 1	0.5 * Nameplate Output
1 < W ≤ 51	0.09 * Ln(Nameplate Output) + 0.50
51 < W ≤ 250	0.85
Nameplate Output Power	**Maximum No-Load Power Consumption**
0 < W < 250	0.50 W

F.6.2 Future Standards

- Version: 2 for EPS
- Compliance: Mandatory
- Effective: April 26, 2011

Table F.13. Version 2 Levels for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode – Less than 6 Volts	Minimum Efficiency in Active Mode – Greater than 6 Volts
0 < W ≤ 1	0.497 * Nameplate Output + 0.067	0.480 * Nameplate Output + 0.140
1 < W ≤ 51	0.0750 * Ln(Nameplate Output) + 0.561	0.0626 * Ln(N ameplate Output) + 0.622
51 < W ≤ 250	0.86	0.87

Nameplate Output Power	Maximum No-Load Power Consumption AC/AC	Maximum No-Load Power Consumption AC/DC – Less than 6 Volts	Maximum No-Load Power Consumption AC/DC – Greater than 6 Volts
0 < W ≤ 51	≤ 0.50 W	≤ 0.30 W	≤ 0.30 W
51 < W ≤ 250		≤ 0.50 W	No Maximum

F.7 EU (Subset of Member Countries)—Group for Energy Efficient Appliances

Developed by the Group for Energy Efficient Appliances, which includes government agencies and institutions from Denmark, the Netherlands, Sweden, Switzerland, Germany, France, and Austria, the GEEA standards are voluntary. The purpose of the GEEA, organized in 1996, is to harmonize national regulations pertaining to electronics and home office equipment. Minimum energy-efficiency requirements are among the product characteristics GEEA addresses, including MEPS for external power supplies and battery chargers.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 150 watts. In addition to EPS and BC, this standard applies to portable personal equipment, which is defined as "equipment that is sold as part of a product with non-removable rechargeable batteries and is sold with the aim of recharging batteries."

F.7.1 Current Standards

- Version: N/A
- Compliance: Voluntary
- Effective: 2007

Table F.14. GEEA Levels for EPS and "Portable Personal Equipment" Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
$0 < W \leq 1$	0.49 * Nameplate Output
$1 < W \leq 49$	0.09 * Ln(Nameplate Output) + 0.50
$49 < W \leq 150$	0.84
Nameplate Output Power	**Maximum No-Load Power Consumption***
$0 < W < 150$	0.30 W

* Includes Battery Chargers

F.8 Israel – SI 4665.2 (AS/NZX 4665.2-2005)

Administered by the Standards Institution of Israel (SII), the SI 4665.2 standards are a Hebrew translation of the AS/NZX 4665.2-2005 standards developed by Australia. These voluntary standards apply to external power supplies only.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 250 watts. Notable exclusions are devices with batteries that attach directly, replacements, and medical devices. The scope and test procedures are identical to those in the Australian standards (*i.e.*, EPA EPS).

F.8.1 Current Standards

- Version: SI 4665.2
- Compliance: Voluntary
- Effective: December 2007

Table F.15. SI 4665.2 Levels for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W ≤ 1	0.49 * Nameplate Output
1 < W ≤ 49	0.09 * Ln(Nameplate Output) + 0.49
49 < W ≤ 250	0.84
Nameplate Output Power	**Maximum No-Load Power Consumption**
0 < W < 10	≤ 0.50 W
10 ≤ W ≤ 250	≤ 0.75 W

F.9 Korea – e-Standby Program

The e-Standby standards, developed and implemented by the Ministry of Commerce, Industry, and Energy (MOCIE) and Korea Energy Management Corporation (KEMCO), are voluntary. However, a presidential directive with mandatory standby power limits, similar to President George W. Bush's Executive Order 13221, is likely to be implemented by 2010.

Power converters covered under this standard include all single-voltage EPSs with nameplate output power up to 150 watts and cellular telephone chargers. Notable exclusions are EPSs with charge circuitry.

F.9.1 Current Standards

- Version: N/A
- Compliance: Voluntary
- Effective: January 1, 2007 for EPS, January 1, 2006 for BC

Table F.16. e-Standby Program Levels for EPS Active-Mode Efficiency and No-Load Power

Nameplate Output Power	Minimum Efficiency in Active Mode
0 < W ≤ 1	0.49 * Nameplate Output
1 < W ≤ 49	0.09 * Ln(Nameplate Output) + 0.49
49 < W ≤ 150	0.84

Nameplate Output Power	Maximum No-Load Power Consumption
0 < W ≤ 10	≤ 0.50 W
10 < W ≤ 150	≤ 0.75 W

Table F.17. e-Standby Program Levels for Cellular Telephone Charger No-Load Power

Maximum No-Load Power Consumption
≤ 0.50 W